Essays on the Effects of Rural-Urban Migration on Migrants' Behaviour in China

Marriage, Fertility, and Cigarette Smoking

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Declaration

This thesis is an original work. None of the work has been previously submitted by me for the purpose of obtaining a degree or diploma in any university or other tertiary education institution. To the best of my knowledge, this thesis does not contain material previously published by another person, except where due reference is made in the text.

I am responsible for remaining errors and omissions.

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Abstract

The thesis examines the effects of rural-urban migration on migrants' marriage, fertility and smoking behaviour. This research attempts to fill these gaps. The data used are from the Chinese Rural Household sample of Rural-Urban Migration in China and Indonesia (RUMiCI) project.

Chapter 2 analyses the effect of rural-urban migration on fertility behaviour of rural females in China. The results show that the rural-urban migration decreases the number of births and delays the timing of the first birth. On average, the first birth is delayed about seven months. Furthermore, it is suggested that female migrants postpone their marriages, and subsequently the timing of the first birth.

Chapter 3 examines the correlation between the timing of the first marriage and the first rural-urban migration. It is found that male migrants marry four months earlier and female migrants four months later than their rural counterparts. In details, the accelerating effect of migration for males significantly depends on the duration of migration; for females, the postponement effect of migration varies across birth cohorts.

Chapters 4 and 5 explore the effect of rural-urban migration on cigarette smoking from two perspectives - smoking prevalence and age of smoking onset. The results show that the rural-urban migration has a significant and positive effect on current smoking prevalence. In terms of the timing of smoking onset, rural-urban migration can increase the hazard rate of smoking substantially, and counterfactual experiments show that the lifetime prevalence of smoking can also be increased significantly.

More alarmingly, the effect of migration is extremely substantial for younger birth cohorts.

Key words: Rural-Urban Migration; Fertility; Marriage; Cigarette Smoking

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Chapter 1

Introduction

Since the start of economic reforms in 1978, China has experienced a substantial economic growth. Parallel to the fast growth, China has also witnessed an unprecedented scale of rural to urban migration. Between the early 1980s and 2009, the number of rural-urban migrants escalated from 12 million in the early 1980s to 145.3 million in 2009 (National Bureau of Statistics of China, 2010; Zhao, 2000). The key object of this thesis is to contribute new insights into various aspects of the effect of rural-urban migration on the migrants' behaviour by investigating three important issues: fertility, marriage and cigarette smoking.

First, the issue of rural-urban migrants' fertility behaviour has important implications for China. This is because there are about 150 million rural-urban migrants (accounting for more than 11% the total population). If migration has changed migrants' fertility behaviour, this has an immense impact on the trend of population in China. In addition, migrants are not registered in urban areas, and do not reside in rural areas, and hence the surveillance of both urban and rural governments on migrants are very weak. Therefore, the government is concerned that rural-urban migrants are able/more likely to violate the family planning regulation and exceed the regulatory quota.

Second, delays in the first marriage, both historically in developed countries and currently in developing countries, are of interest to demographers and economists because of the close correlation to the complete fertility. Literature shows that variance in the age of the first marriage is associated with a difference in fertility because women who marry later will have a shorter reproductive span, hence a lower complete fertility rate on average (Department of International Economic and Social Affairs, United Nations, 1990; Jones and Gubhaju, 2009; Kohler et al., 2002; Lutz and Skirbekk, 2005; Morgan and Rindfuss, 1999).

Finally, China has the world's largest smoking population, the largest non-smoking population exposed to secondhand smoke, and the largest death toll due to smoking (GATS, 2010). This is not only because of the immense population in China, but also because of the high prevalence of smoking. Previous studies on smoking suggest that immigrants are a very high-risk population group because social networks shrink after migration, and loneliness and increases in job pressure are important factors affecting smoking onset (Yang et al., 2009). Thus, in order to control tobacco consumption efficiently and effectively, research on the effect of rural-urban migration on cigarette smoking is necessary. Given the addictive nature of tobacco consumption and the fact that the earlier the uptake smoking, the greater the addiction will be, combined with the concentration of rural-urban migrants in China in young birth cohorts, then issue of the effect of migration on the timing of smoking onset should be of even more of a concern.

The main part of the thesis consists of four chapters. Chapter 2 examines whether the rural-urban migration increases the fertility rate of rural women in China, and whether migration accelerates or postpones the timing of the first birth. Chapter 3 investigates the role of migration on rural people's timing of the first marriage. Chapter 4 analyses the effect of rural-urban migration on cigarette smoking. Chapter 5 tests whether the rural-urban migration is a factor affecting smoking onset, followed by final conclusions and policy implications.

1.1 The Effect of Rural-Urban Migration on Fertility Behaviour

First, the number of births is modelled as a function of a dummy variable indicating whether the women have had a migration experience or not, along with a host of other variables of the characteristics at personal, household and county levels. The main challenge of this study is to solve the endogeneity problem caused by the omitted variable(s) and reverse causality. For example, health status affects both fertility plans and migration decisions. Healthy women are more likely to migrate, and at the same time have more children. Alternatively, women with more children are less likely to migrate. In other words, the fertility behaviour can inversely affect migration decision. Therefore, any OLS estimation may bias the estimate of the causal effect of migration on fertility rate. In order to solve this problem, I use a dummy variable indicating whether any extreme rainfall event happened when the female was aged between 16 and 25 as an instrumental variable (IV) for the migration status. In rural China, the occurrence of extreme weather event(s) will reduce the immediate agriculture income. And a large income shock may lead to rural-urban migration because Chinese peasants are confronted with strict credit constraints. As a result, the occurrence of extreme weather event(s) is correlated with the personal migration decision. It might also be argued that extreme weather conditions affect fertility in which case this would be an inappropriate instrument, since the exclusion assumption would be violated. To strengthen the case for the application of the instrument I restricted the age interval of women to between 16 and 25 years. Hence, women aged between 16 and 25 are more likely to migrate due to extreme weather events. The IV estimation reveals that the fertility of a rural women decreases by 0.81 because of the rural-urban migration due to the extreme rainfall events. The effect of migration is very large, compared with the average fertility of all married females in the sample used, 1.63 children.

Second, the literature indicates that the delay of the first birth often leads to a reduction in whole-life fertility (see e.g. Kohler et al., 2002; Lutz and Skirbekk, 2005; Morgan and Rindfuss, 1999). In order to analyse the effect of rural-urban migration on the timing of the first birth, a piece-wise constant proportional hazard model is applied. The estimations show that among the married rural women, rural-urban migration has no influence on the timing of the first birth. However, after including the unmarried rural women, to meet the selection issues that arise from confining the analysis to married women, migration is significantly and negatively correlated with the timing of the first birth. Furthermore, after controlling the marriage status, the effect of migration disappears. Counterfactual experiments show that averagely rural-urban migration postpone the age of the first birth by seven months.

1.2 The Effect of Rural-Urban Migration on Marriage Behaviour

The results of Chapter 2 suggest that rural-urban migration affects the fertility behaviour by differing marriage. So, Chapter 3 examines the extent to which the rural-urban migration affects the first marriage age for female migrants in China. However, the analysis is not restricted to rural females, and male rural-urban migrants' marriage behaviour is also investigated. In order to identify the relationship between first migration and first marriage, three problems need to be dealt with. The first one is the censored observation problem. That is, there are many individuals in the sample still unmarried when the survey was conducted. The second one is about the selection effect possibly caused by unobserved heterogeneities. Many unobserved factors, for example career ambitiousness, can affect the hazards of both migration and marriage. Those who married before the survey, are more likely from the group of individuals with low ambitions. Consequently, the effect of first migration on the timing of first marriage is underestimated. The third one is the reverse causality problem. That is, the rural-urban migration can affect the timing of marriage, whereas the timing of marriage can impact on the rural-urban migration decision reversely.

A bivariate mixed proportional hazard model is applied to solve these three problems subject to the *No Anticipation* assumption (Jaap et al., 2005). This assumption means that people do not anticipate the exact timing of their rural-urban migration, or even if they did, they would not adjust their marriage plans whether or not they migrate in the future. Obviously, the assumption is violated in this part of analysis. So, the relationship identified by the estimation is still an association. The results reveal that the rural-urban migration is associated with an increase in the hazard of the first marriage for the rural males, but a reduction for the rural females, although the changes in the expected age of the first marriage are not very large.

1.3 The Effect of Rural-Urban Migration on Cigarette Smoking

Chapter 4 investigates the relationship between the rural-urban migration and smoking behaviour. The results of OLS estimation show that the rural-urban migration has no impact on smoking prevalence. However, the OLS estimations suffer from the endogeneity problem due to omitted variables, for instance, health status and risk preference, which may be correlated with the decisions on both migration and smoking. In order to mitigate the endogeneity problem, firstly, I apply an instrument variable (IV) approach. The instrumental variable for the rural males' migration decisions is the overall county government expenditure on *Supporting Agriculture Production* between 1993 and 2003. Commonly, for the counties which are suitable for agricultural production, the local governments are willing to allocate money on agricultural production processes, for example irrigation systems. So, in such counties, the labour demands of the agricultural sector are higher, hence the likelihood of migration for rural males is lower. It is reasonable to assume that the expenditure by local government does not directly affect personal smoking behaviour, therefore the instrumental variable used is valid.

Secondly, with the help of panel data, fixed effect (FE) models are employed to correct the inconsistency caused by time-constant unobserved heterogeneity. With respect to the relationship between smoking and migration, the risk preference, which normally remains unchanged in the short term, is a component of the unobserved heterogeneity. However, health status, another unobserved heterogeneity, may vary dramatically even over two continuous years, hence the estimation of FE is still possibly inconsistent. Furthermore, because risk preference hardly follows a normal distribution, the random-effect model is not employed in this study.

The results of both IV and FE models show that rural-urban migration increases the prevalence of smoking significantly. And the results of IV is too large to be trusted, but the results of FE models is quite robust.

In terms of the age of smoking onset, the results of the proportional hazard models reveal that the relationship between the rural-urban migration and the timing of onset of smoking are positive. However, the results may suffer from the selection effect caused by the unobserved heterogeneity. Thus, in Chapter 5, a bivariate mixed proportional hazard model is employed, which assumes that all selection effects can be captured by the observable and unobserved heterogeneity. The results show that rural-urban migration can increase the hazard of smoking onset significantly. Additionally, counterfactual experiments predict that the lifetime prevalence of smoking is increased significantly by migration and that the earlier migration starts, the larger is its effect on the prevalence of smoking.

1.4 Main Data

The main data used in this thesis is from the Rural Household Survey (RHS) of the Rural-Urban Migration in China and Indonesia (RUMiCI) project which was established to investigate the impacts of internal migration within China and Indonesia (RUMiCI, 2011). From 2008 to present, four waves of the surveys in China have been completed. The Chinese survey has three samples: 5,000 migrant, 5,000 urban and 8,000 rural households. It is made up of 80 counties from nine of the largest provinces sending and receiving migrants: Shanghai, Jiangsu, Zhejiang, Hubei, Sichuan, Guangdong, Henan, Anhui and Sichuan. RUMiCI's sampling design for the China RHS is based on that of the Annual Rural Household Survey conducted by China's National Bureau of Statistics (NBS). Thus, the representativeness of the RUMiCI survey is only within all the provinces sampled by the survey. The information is collected on individual and household demographic and economic characteristics, as well as on the migration history in each wave. If the participants were absent, the questions would be answered by those who knew the information (in most cases, by the householders or their spouse). And the proportion of responses answered by proxies is a little bit less than 50%. In addition, in the third wave of RUMiCI, the information on the history of marriage and smoking is also collected.

One outstanding advantage of the RHS of RUMiCI is its extremely high response rate because the survey is carried out by NBS whose credibility is quite high, particularly in rural China. Another advantage is that there are very few respondents missing due to migration. The reason is that the sampling of RUMiCI is based on the registration information from the Household Registration System (*Hukou* system). Although there are some relaxations in China now, it is still unlikely for rural people to obtain urban *Hukous*. As a result, most rural-urban migrants are still in the sampling frame of the Annual Rural Household Survey even if they have already migrated to cities some time ago. Furthermore, the questions for those household members who were absent due to the rural-urban migration when interview, were answered by the household heads or whoever knew the information. Thus, the sample selection problem because migrants failed to participate in interviews is not serious.

Chapter 2

The Effect of Rural-Urban Migration on Fertility Behaviour: Evidence from China

Abstract In this chapter, I investigate the effect of rural-urban migration on women's fertility behaviour in rural China. First, although the IV estimate of this effect is too small compared with the OLS estimate, a series of sensitivity tests confirm the robustness of the results. Furthermore, in order to analyse whether rural-urban migration affects the timing of the first birth, I employ a proportional hazard model. The estimation results show that rural-urban migration is unrelated to the timing of the first birth for married females; however, if unmarried females are included, migration and the timing of the first birth is significantly and negatively correlated. One possible explanation for these findings is that females in rural China postpone their marriage, and subsequently the timing of the first birth, though investigating this possibility further will be the topic of Chapter 3. Counterfactual experiments show that migration only delay the first birth by seven months on average. The estimation results also indicate that females from the younger birth cohort, Post-1980, have a lower overall

propensity to experience a first birth, and for them the effect of rural-urban migration is even larger.

Key words: Migration; Fertility Rate; Timing of First Birth

2.1 Introduction

Ever since Malthus (1798) noticed about the effect of immigration on population increases, the fertility rate of migrants has been of interest to both economists and demographers. A lot of research demonstrated that migration changes the fertility behaviour in many countries (Beine et al., 2008; Goldstein, 1973; Hwang and Saenz, 1997; Lee, 1992). Several hypotheses are proposed to explain the difference in the fertility behaviour between migrants and people from the sending areas and those from the receiving areas, e.g. the adaptation of migrants to a different culture, the direct effect of the disruption caused by migration, and the fact that migrants are selective (Hervitz, 1985; Lee, 1992; Rundquist and Brown, 1989; Singley and Landale, 1998). Recently, researchers have started to pay attention to this issue in the China context partially because the large scale of rural-urban migration provides researchers with an opportunity to investigate migrants' fertility behaviour (Goldstein et al., 1997; Liu and Goldstein, 1996). Besides contributing to the general literature, investigating the changes in female rural migrants' fertility behaviour has special meaning for China. Considering that the scale of migrants is very large - about 150 million, accounting more than 11% the total population - if rural-urban migration is an important factor of changes in fertility behaviour, it has an impact on the trend of population growth and many other aspects of China. Different from the 1980s and 90s when the family planning policy was implemented restrictedly, increases in migrant fertility may not be a concern any longer, but a desire of the government because China is suffering from one serious problem - aging population. Roughly 35% of the population was predicted to be age 60 or older in 2050 (Banister et al., 2010). This problem led to shrinking working-age population and increasing dependency ratios. The same paper by Banister and colleagues demonstrates that the ratio of individuals age 15-64 to those younger and older will be slated to decline rapidly in the coming decade, which could further conceivably herald insufficient supply of eldercare, sharp increases in income inequality and slow economic growth (Hu et al., 2012; Peng and Hu, 2011; Zhong, 2011). The decreases in migrant fertility would further deteriorate the situation.

The main question of this study is to investigate the impact of rural-urban migration on females' fertility behaviour in China. Although there have been quite a few past studies on the issue (see e.g. Goldstein et al., 1997; Liu and Goldstein, 1996), the understanding is far from enough because these studies suffer from the following three problems. First, most of them focused on the fertility rate. However, fertility behaviour can be looked at from two related aspects: the total number and the timing of births. Previous analysis (see e.g. Kohler et al., 2002; Lutz and Skirbekk, 2005; Morgan and Rindfuss, 1999) shows that the delay of first birth often leads to a reduction in whole-life fertility. The shortening of the reproductive span complicates the attainment of the desired level of fertility because of higher levels of sub-fecundity and sterility in older age groups. However, the studies on the timing of births in China (see e.g. Goldstein et al., 1997) failed to employ the hazard model and hence their estimation results may be inconsistent. Furthermore, studies on the fertility rate usually identify the correlation relationship instead of the causality between migration and fertility because of the endogeneity problem (see e.g. Goldstein et al., 1997; Liu and Goldstein, 1996). One possible reason is the omitted variable(s). For example, career ambitions affect both fertility plans and migration decisions because ambitious women are more likely to migrate, and have fewer births. Another possible unobserved component is health status. The more healthier the woman is, the more likely she migrates, and the more children she has. Therefore, any OLS estimation is inconsistent. However, it cannot be predicted whether the OLS estimate is over- or under-estimated because the correlation between migration and omitted variables is not clear. Alternatively, the reverse causality can also lead to a endogeneity problem. Specifically, women may choose to migrate and hence have fewer children, however, it is also possible that women who have more children are less likely to leave hometown. Finally, past research mainly focused on the married females (see e.g. Goldstein et al., 1997), and thus suffers from the sample selection problem. The researchers did this because there is a social stigma attached to births out of wedlock, particularly in rural China. As a result, unmarried rural females are commonly childless. It seems to be reasonable to exclude the unmarried females when analysing fertility behaviour. However, it can be argued that females who want to give birth get married, while those who do not want children may remain unmarried and are more likely to migrate. Thus, the regression results based on the married sample undoubtedly suffer from sample selection bias.

To solve these problems, firstly, in order to deal with the endogeneity problem when analysing the number of births, I employ a dummy variable indicating whether any extreme rainfall event ever happened when the rural woman was aged between 16 and 25 as an instrument variable to the rural-urban migration decision. Secondly, a proportional hazard model is applied to analyse the effect of rural-urban migration on the timing of the first birth. Thirdly, I include the unmarried rural women to the sample in order to investigate the effect of possible sample selection bias on the estimation results.

The results reveal that rural-urban migration significantly reduce the fertility rate of female migrants in China, and the negative correlation between rural-urban migration and the timing of the first birth is also significant. Further, counterfactual experiments show that on average migration defers the birth first by about seven months which seems to be very small. Combining these findings, migration seems to have a larger postponement effect on the second and (or) third births, and consequently reduce the fertility rate significantly. A detailed analysis demonstrates that the correlation between migration and the timing of the first birth varies across different birth cohorts. For the younger cohort, Post-1980, the correlation strongest: The hazard of the first birth of migrants is about 25% to 35% less than that of the older birth cohorts.

The chapter is organized as follows. Section 2.2 reviews the history of family planning policy and rural-urban migration in China. Section 2.3 describes the estimation strategy and the data used in the study. Section 2.4 presents the estimation results, followed by final conclusions.

2.2 Family Planning Policy and Rural-Urban Migration

Starting from the 1970s, China implemented two pivotal policies: one related to severely curbing the high-speed growth in population and the other related to economic reform. Both had significant effects on the society and economy in China.

The first, the family planning policy, is well known as the *one-child* policy; however, there are two misunderstandings about this particular policy. First, strictly speaking, the family planning policy is not a *one-child* policy. In fact, only the population in urban areas is subject to *one-child* policy strictly, while couples in the rural areas are permitted to have two children if certain conditions are satisfied. The most notable conditions include whether the couple live in a poor area, whether their first birth is a girl, and whether either of the couple comes from a minority ethnic group. The other misunderstanding of this policy is that it was implemented uniformly. In fact, localization is one key factor of this most important national policy and its implementation may vary even cross villages (Short and Zhai, 1998). To measure the degree of the localization of the fertility policy, Gu et al. (2007) constructed an index at the prefecture level. The index is used in this study to control for the effect of fertility policy.

The second, the *economic reform policy*, provided peasants with the opportunities and incentives to more efficiently allocate their resources. This released a vast of surplus labour force (Woon, 1993). In the 1990s, the income gap between urban and rural areas increased, and seeking better jobs in cities became the main reason for rural-urban migration. World Bank (2009) shows that the population migrating from rural areas to urban areas grew from 38.9 million in 1997 to 137 million in 2007. That is, the migrant population increased by 3.5 times in one decade. The latest report of National Bureau of Statistics of China (2010) indicates that in 2009, the number of rural-urban migrants jumped to 145.3 million in 2009.

Although peasants can migrate to urban areas, few of them can become permanent residents in cities because of the Household Registration System (*Hukou* system). In China, residents are tied to the place where they were born, and their *Hukou* status, whether rural or urban, determines people's social benefits and opportunities to get educated and employed. Although there were some relaxations in the system, for a rural-urban migrant without an urban *Hukou*, it is still impossible to get equal access to welfare and social benefits compared with urban residents. As a result, the migrants cannot enjoy high level of public support as their urban correspondents, and and even cannot compare with those who stay in rural areas. A 2003 survey on 4,714 rural-urban migrants in Shanghai showed that only 14% had health insurance (Feng et al., 2002); however, the same figure in rural areas is more than 70% (Wagstaff et al., 2009). In terms of the schooling of children, the enrolment rate is as high as 98% in 2004 (Ministry of Education of the People's Republic of China, 2004); however, for rural-urban migrants, particularly temporary ones, taking cities in Guangdong province as an example, the enrolment rate is only 60% (Liang and Chen, 2007). Thus, the high level of social benefit is not the reason for migration; on the contrast, the lack of obstetric and maternal service, childcare and medical care in urban area for migrants could discourage their fertility.

Rural-urban migrants face a totally different social environment after migration and hence may have different fertility behaviour compared with people in the sending areas. In order to explain the possible difference between migrants and non-migrants in general, several theoretical hypotheses are proposed (Hervitz, 1985; Lee, 1992; Rundquist and Brown, 1989; Singley and Landale, 1998). First, the adaptation hypothesis suggests that migrants may be assimilated into destinations and change their fertility preference. This hypothesis predicts a lower fertility for migrants than non-migrants in rural sending areas. The second hypothesis, the disruption hypothesis, suggests that the fertility rate of migrants should be very low because migrants may defer births due to separation or other disruptive factors. However, the low fertility rate is just temporary and may be resumed after the migrants and their spouses reunite. Finally, the selection hypothesis argues that the migrants are not randomly chosen from their origin. That is, migrants are a specific group of people whose fertility preference is different from the others in the origin areas. On the one hand, it is possible that in order to have more children some women in rural China may migrate to urban areas because migrants are not registered in urban areas. They choose not to reside in rural areas because the surveillance of both urban and rural governments on migrants is very weak. So, the fertility rate of migrants may be higher than that of non-migrants. On the other hand, ambitious rural women may be more likely to migrate to cities, and at the same time may have a lower intention to give birth. So, their fertility rate of migrants is possibly lower than that of non-migrants. Overall, the effect of rural-urban migration on women's fertility behaviour is mixed.

A study, which surveyed urban women, rural women who migrate, and rural women who have never migrated in two of China's provinces (Hubei and Anhui) at the end of the 1980s, find that migration delays the first birth for rural women significantly; and female migrants do not have more children than their non-migrant counterparts (Goldstein et al., 1997; Liu and Goldstein, 1996). And Yang (2000) claims that rural-urban temporary migrants have a lower fertility rate because of the separation of spouses.

2.3 Estimation Strategy and Data

2.3.1 Estimation Strategy

2.3.1.1 Fertility Rate

The fertility of a woman, i, can be specified as:

$$F_i = X_i\beta + M_i\gamma + v_i, \tag{2.1}$$

where F_i is the number of births for woman i ever gave; X_i is a vector of other explanatory variables; M_i is a dummy variable indicating whether woman i ever migrated. The coefficient of interest is γ which indicates the effect of rural-urban migration on the fertility rate.

The main empirical challenge of estimating Equation 2.1 is the endogeneity problem which is likely result from reverse causality or (and) omitted variable(s). Specifically, women may choose to migrate and hence have fewer children, however, it is also possible that women who have more children are less likely to leave hometown. Alternatively, the omitted variable(s) may also be the reason of inconsistent estimates.

For example, career ambitions affect both fertility plans and migration decisions, because as literature documented, most unmarried women return to their villages to marry and bear children, and never migrate again (Davin, 1999; Du, 2000; Fan, 2004; Jacka, 1997). In this case migration and omitted variables is negatively correlated, and the estimate of OLS is over-estimated. Another possible unobserved component is health status. The healthier the woman is, the more likely she migrates, and the more children she has. In this case, migration is positively correlated with the omitted variable. Overall, it cannot be predicted whether the OLS estimate is over- or under-estimated because the correlation between migration and omitted variables is not clear.

A valid instrument Z can be used to solve the endogeneity problem. The first stage regression of instrumental variable approaches can be expressed as

$$M_i = X_i\alpha + Z_i\eta + \mu_i, \tag{2.2}$$

where Z_i is the instrumental variable. To be valid, the instrument must satisfy two conditions: it is correlated with the endogenous variable (the woman's migration decision), but does not directly affect the dependent variable (the number of births).

In this study, I used a dummy variable indicating whether any extreme rainfall event happened when the female was aged between 16 and 25 as an instrumental variable. In rural China, agricultural income is highly related to the weather. So, the occurrence of extreme weather event(s) will reduce the immediate agriculture income. For people facing strict credit constraints, a large income shock may lead to rural-urban migration. Based on similar logic, several researchers tried to either assess the rainfall's direct effect on off-farm labour supply decisions (Rose, 2001), or use the rainfall amount as an instrumental variable for migration decisions or migration social networks (Munshi, 2003).

In order to ensure that the instrument is highly correlated with migration decisions, I restricted the age interval to between 16 and 25 years. The reason for this restriction is that most rural children finish compulsory education at 16 years and get married before 25 years. Thus, women aged between 16 and 25 are more likely to migrate due to extreme weather events. In other words, the setting ensures the instrumental variable, whether an extreme rainfall events happened when the female was aged between 16 and 25, is strong enough.

It can be argued that there may be a mechanical correlation between the fertility rate and the occurrence of extreme weather events. The reason is that for younger women, particular those aged less than 25, are less likely experience an extreme weather event. At the same time, they are less likely to be married and so have few children. If this is the case, the exclusion of the mature group would lead to dramatic change in the estimate. In the next section, the estimation result of younger sample will be introduced as a robustness check.

It can also be argued that an extreme rainfall event may increase the mortality rate of children, and then increase the fertility rate. If it is the case, the exclusion restriction would be violated and the estimates would be inconsistent. It is true that Chinese parents, who lose their child(ren) during the rainfall disaster, are permitted more births by the family planning regulation. The violation in the exclusion restriction due to this fact, however, may not be serious because the mortality rate due to the rainfall disasters is very low in China especially after 1960s. Take the flood in 1998 which was the worst one in China in the last century, as an example. Although 29 of the total 34 provinces in China suffered from this flood, the total number of deaths due to the flood was only 4,150 out of more than one billion people affected (Ministry of Water Resources of the People's Republic of China, 1999). Although I cannot make any detailed quantitative analysis because the mortality rate of children due to floods is not available, extreme rainfall events seem not to affect the number of births in this way. Further, it is also possible that floods can also affect the number of birth by postponing marriages, shortening the span of fertility and reduce the number of births. And if this is the case, the effect of flood on the number of birth should be larger for younger birth cohorts. Along this line, the exclusion of mature cohorts would result a dramatic change in the estimate. It will be analysed in the next section. Admittedly, the exclusion restriction could be violated in many other ways, such as the preference of risk and the number of births could be changed by extreme rainfall events. More investigations are guaranteed after more related information is collected.

The other explanatory variables can be classified into four categories: individual, household, village, and county levels. Individual level variables include birth order, whether from a minority ethnic group, schooling years, and age. Taking into consideration that the effect of age on the number of births may be non-linear, I employ a linear splines setting. Specifically, the slope of age can change across different age intervals but stays constant within the same interval. In this study, three age intervals are chosen: less than 20 years, between 20 and 30 years, and more than 30 years. It should be noted that the identification of the age effect is based on the cross-section data, and thus it is impossible to distinguish the effect of age from that of birth cohort. The characteristics of household controlled are whether from a cadre family, and the household income per capita in 2007. Generally, the cadre households have to obeying regulations and laws including Family Planning Policy more strictly, thus the sign of this variable is expected to be negative. I also controlled for the terrain of the village, and whether the home county or township is identified as a poor county or township by the government, the fertility policy index and county fixed effects.

2.3.1.2 Timing of the First Birth

To examine whether the timing of the first birth is part of the story of migration effect on average fertility, a continuous-time proportional hazard model is employed. The core concept modelled is the hazard of the first birth at time t taking the form

$$h(t,X) = h_0(t)\exp(X'\theta)\exp(M(t)\delta), \tag{2.3}$$

where $h_0(t)$ represents the baseline hazard at time t. X is a vector of time-variant and time-invariant variables, and θ is a vector of coefficients estimated, while $M(t)$ is a time-variant variable which changes from zero to one once the woman i migrates to an urban area, for women who never migrated, the dummy variable continues to be zero, while for those who ever migrated, the dummy variable equals zero before the first migration and one afterwards. So, in this study, the control group is those rural women without migration experience. δ measures how largely rural-urban migration affect the timing of the first birth. Age 16 is assumed to be the age at which the potential exposure to child birth begins for rural women. Although the Chinese Marriage Law stipulates females' legal marriage aged is 20, marrying earlier than the legal marriage age is still possible in rural China (Li, 1993; Lv, 2010). The duration between age 16 and the age when giving the first birth is the spell of interest. Please also note, if the rural women have not given any birth by the time of survey, they will be regarded as keeping childless.

In this study, the baseline hazard follows a piecewise form. That is,

$$h_0(t) = \exp(\sum_n h_{0n} I_n(t)), \tag{2.4}$$

where the subscript n refers to age intervals and $I_n(t)$ equals one for the age interval n, and zero otherwise. In other words, the baseline hazard in each age interval is constant. Specifically, I distinguish thirteen age intervals: between 16 and 19 which denotes the period of illegal marriage, and the following eleven intervals are one year in length (age $20, 21, 22, \cdots, 30$), and the last one (31+ years) is half open.

The lack of very detailed retrospective information on education prevents us from a complete reconstruction of graduation history. I generate a rough measurement on the year of graduation based on the information of the highest level of education completed by assuming that all the females enrol in school at ages six, and do not break from the normal education path until graduation [1]. All the remaining control variables are time-invariant, including minority status, schooling years, birth order, birth cohort effects, terrains, and county fixed effects. Unlike the analysis of fertility rate, I cannot control the household income, cadre family or fertility policy factor because past information on these variables is unavailable.

[1] I also test the sensitivity of this assumption below by assuming females enrol at age eight. These two time-variant variables, whether a female was enrolled at school by assuming that the enrol age is six or eight, can give the bounds for the enrolment effect.

2.3.2 *Data and Data Description*

The main data used in this study is from the first three waves of Rural-Urban Migration in China and Indonesia (RUMiCI) project. The Chinese Rural Household Survey (RHS) of RUMiCI comprises 8,000 rural households from nine provinces. All the household members were interviewed. If any member was absent at the time of interview (e.g. because of rural-urban migration), the questions were answered by the household head or whoever knew the information. The information was collected on individual and household demographic and economic characteristics, as well as migration history.

To form a comparable sample of the rural-urban migrants and non-migrants, I restrict the sample to the rural females aged between 16 and 45 in 2008. This gives me a sample of 4,818 married and 1,930 unmarried rural women (i.e. overall 6,748 women). Furthermore, among all the married women, I successfully matched 3,574 women with their oldest child to obtain information on the timing of the first birth. Another 266 females who had married but had not had any child as yet are treated as censored observations. By doing so, a data set of 3,840 married women, whose fertility and marriage history can be reliably constructed, is derived. This data set is referred to as the married restricted sample. Note that in rural China a very serious stigma is attached to birth out of wedlock, and hence in the sample none of the unmarried females had given a birth. After including unmarried females who had never given any birth before 2008, the full restricted sample comprising 5,770 females is derived.

Strictly speaking, of interest in this study is not the timing of the first birth but the timing of the birth of the eldest surviving child. In other words, there is a measurement error in the timing of the first birth because it is possible that some women had given birth before the eldest surviving child was born. Nevertheless, according to World Population Prospects (Population Division, Department of Economic and Social Affairs, United Nations, 2011), in China between 2005 and 2010 the Infant Mortality Rate (IMR) and Under-five Mortality Rate were 2.2% and 2.6% respectively, while the mortality rate for the group aged between 5 and 30 years (which the majority of the eldest children in the sample come from) is much lower. So, the measurement error in the timing of the first birth may not be serious.

In order to control for the effect of the family planning policy, I use the index from Gu et al. (2007) which is a weighted average of birth quotas permitted by the local family planning policy on the prefecture level. Let us assume the population in a prefecture composes 10% ethnic minority, 30% with urban Hukou and 60% with rural Hukou. Further, assume in the same prefecture that urban couples are allowed to have one child, rural couples 1.5 children (that is, if the first child is female, then they may have the second one), and the number for minority couples is two, then the policy index for this prefecture is 1.4 ($= 30\% \times 1 + 60\% \times 1.5 + 10\% \times 2$).

Although the index ignores the possibility of marriages between urban and rural humans, it can still embody how restrictively the family planning policy was implemented.

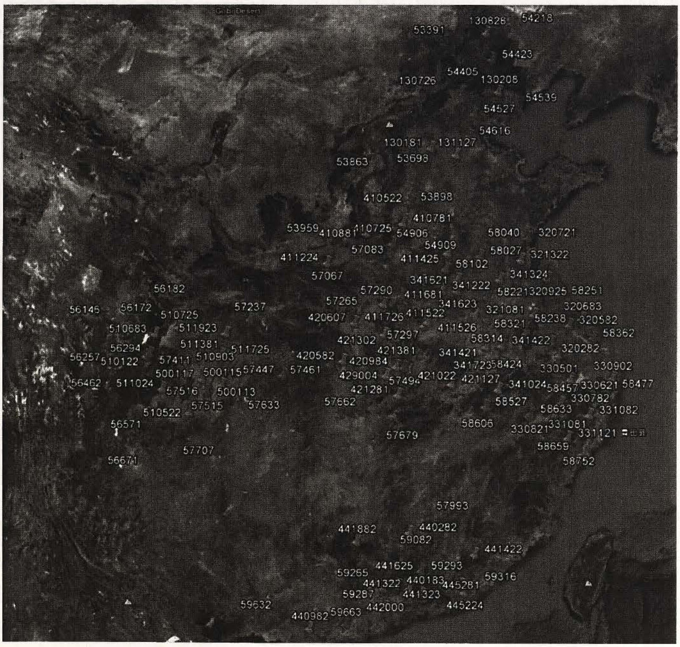

Figure 2.1: The Locations of Weather Stations and Sample Counties of RUMiCI

Note: red pins (with a six-digit number): the counties sampled by RUMiCI; blue pins (with a five-digit number): the weather stations.

The rainfall data set is obtained from National Meteorological Information Centre (NMIC). The historical yearly rainfall amount was collected from 194 weather stations across China between 1951 and 2009. With the help of Google Earth, I matched each of 80 counties surveyed by RUMiCI with the nearest weather station based on their location information (latitude and longitude). Finally, the rainfall data from 33 weather stations were used in this study [2]. All the counties sampled are marked by red pins (with a six-digit number) and and the weather stations blue pins (with a five-digit number) respectively in Figure 2.1. Based on the historical yearly rainfall data (R_{nt} where n and t denote the county and time respectively), I calculate the mean of the yearly rainfall ($\bar{R}_n$) and across-year variance (σ_n) for county n. An extreme rainfall event, I define, occurs in year t if $R_{nt} > \bar{R}_n + 2\sigma_n$ or $R_{nt} < \bar{R}_n - 2\sigma_n$.

Summary statistics of the data are shown in Table 2.1. For simplicity, in this study the women who ever migrated, including current migrants who are currently residing in cities and return migrants who have returned from migration, are called *migrants*, whereas women who have never migrated are called *the non-migrants*. It can be seen that in the married sample (see the first and second column of Table 2.1), the number of non-migrants exceeds that of migrants. The average age of the married migrants is about

[2]Among these 33 stations, 13 were matched to unique county respectively; each of seven stations were matched to two counties; each of three to three counties; each of seven to four counties; each of two to five counties; and one to six counties.

Table 2.1: Summary Statistics

Variable	Married sample: Never migrated	Married sample: Ever migrated	Full sample: Never migrated	Full sample: Ever migrated	Restricted full sample: Never migrated	Restricted full sample: Ever migrated
Age	37.36	32.35	33.79	28.03	33.37	27.59
	(6.24)	(6.67)	(8.96)	(7.64)	(9.18)	(7.70)
Birth Cohorts						
Born before 1970	0.52	0.23	0.41	0.14	0.49	0.13
	(0.50)	(0.42)	(0.49)	(0.35)	(0.49)	(0.34)
Born in the 1970s	0.36	0.42	0.29	0.26	0.32	0.24
	(0.48)	(0.49)	(0.45)	(0.44)	(0.47)	(0.43)
Born after 1980	0.12	0.36	0.30	0.60	0.28	0.63
(1980 included)	(0.32)	(0.48)	(0.46)	(0.49)	(0.45)	(0.48)
With any child	0.97	0.89	0.77	0.54	0.73	0.48
	(0.17)	(0.31)	(0.42)	(0.50)	(0.45)	(0.50)
Number of births	1.63	1.29	1.28	0.78	1.20	0.69
	(0.83)	(0.80)	(0.99)	(0.89)	(0.97)	(0.85)
Birth order	2.40	2.21	2.26	2.06	2.26	2.04
	(1.43)	(1.35)	(1.37)	(1.20)	(1.37)	(1.18)

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Variable	Married sample		Full sample		Restricted full sample	
	Never migrated	Ever migrated	Never migrated	Ever migrated	Never migrated	Ever migrated
Minority status	0.006	0.009	0.003	0.005	0.002	0.004
	(0.06)	(0.09)	(0.05)	(0.07)	(0.05)	(0.06)
Schooling years	7.01	7.50	7.99	8.09	8.18	8.19
	(3.27)	(2.88)	(4.29)	(2.76)	(4.41)	(2.76)
Household income	2.13	2.04	2.16	2.12	2.19	2.11
(10^4 RMB Yuan)	(2.05)	(1.54)	(2.01)	(1.55)	(2.10)	(1.48)
From a cadre family	0.09	0.09	0.09	0.10	0.09	0.10
	(0.29)	(0.29)	(0.29)	(0.30)	(0.29)	(0.30)
From a poor county	0.22	0.28	0.22	0.27	0.22	0.28
or township	(0.42)	(0.45)	(0.42)	(0.44)	(0.42)	(0.45)
Fertility policy index	1.34	1.33	1.35	1.35	1.35	1.36
	(0.20)	(0.19)	(0.19)	(0.18)	(0.19)	(0.18)
Terrain						
Plains	0.50	0.36	0.50	0.38	0.50	0.38
	(0.50)	(0.48)	(0.50)	(0.49)	(0.50)	(0.49)

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Variable	Married sample		Full sample		Restricted full sample	
	Never migrated	Ever migrated	Never migrated	Ever migrated	Never migrated	Ever migrated
Hills	0.39	0.47	0.39	0.45	0.39	0.45
	(0.49)	(0.50)	(0.48)	(0.50)	(0.49)	(0.50)
Mountains	0.11	0.17	0.11	0.17	0.11	0.17
	(0.31)	(0.38)	(0.32)	(0.38)	(0.31)	(0.37)
Whether any extreme rainfall event happened	0.31	0.40	0.28	0.35	0.28	0.34
	(0.46)	(0.49)	(0.45)	(0.48)	(0.45)	(0.47)
Whether married			0.79	0.60	0.75	0.54
			(0.41)	(0.49)	(0.43)	(0.50)
Age of the first birth					23.36[a]	23.06[b]
					(2.61)	(2.50)
Age of the first migration						21.66
						(6.49)
No. of observations	3,208	1,610	4,062	2,686	3,451	2,319

Note: standard deviations in parentheses; *a* sample size is 2,517; *b* sample size is 1,123.

32.35, and non-migrants are five years older than migrants. Correspondingly, more than one third of married migrants are the Post-1980 birth cohort (i.e. those who were born after 1980), and less than one quarter are from the Pre-1970 birth cohort (born before 1970), while only 12% of non-migrants were born after 1980 and more than 50% were born before 1970. In terms of fertility, married non-migrants are more likely to have at least one child and to have more births than married migrants. Married migrants are better educated than married non-migrants, whereas there is only a very slight difference between migrants and non-migrants in their birth order and minority status. Furthermore, migrants' households have a lower income, and migrants are more likely to be from the poor counties. More migrants are from hilly or mountainous areas. Finally and importantly, if any extreme rainfall event happened when a rural woman was aged between 16 and 25, she is more likely to have ever migrated to cities.

Including unmarried females in the sample reduce average age by 4 years for both migrants and non-migrants (see the third and fourth column in Table 2.1). The average of schooling years increases by one and half a year for non-migrants and migrants respectively. Finally, the marriage rate of non-migrants is higher than that of migrants.

The comparisons of the third and fifth columns and that of the fourth and sixth columns of Table 2.1 show that the restricted sample is similar to the full sample. The t-tests indicate that the most significant difference

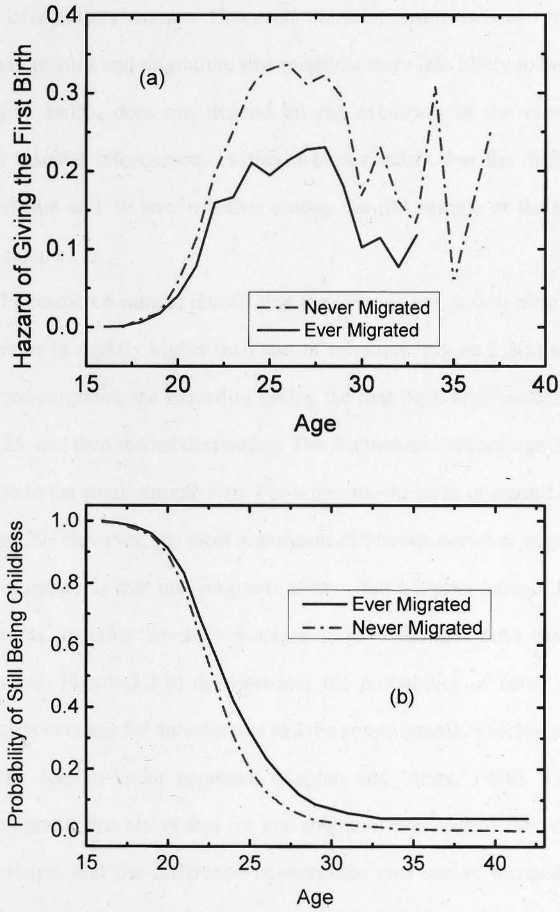

Figure 2.2: Hazard of Giving the First Birth (a) and Probability of Still Being Childless (b): Rural China, Females 16-45 Years

between the full sample and the restrict sample lie in the rates of marriage and of childless women. However, the relationship between these two characteristics and migration, that migrants were less likely to be married or give births, does not depend on the exclusion of the observations with missing information. Further, t-tests confirm that the difference is significant at 1 % level whether among the full sample or the restricted full sample.

The restricted sample reveals that the average age at first birth for non-migrants is slightly higher than that of migrants. Figure 2.2(a) show that for non-migrants, the hazard of giving the first birth kept increasing until age 25, and then started decreasing. The fluctuation between age 33 and 37 is due to the small sample size. For migrants, the peak of hazard occurred at age 27. However, the most significant difference between migrants and non-migrants is that non-migrants always had a higher hazard than non-migrants. In other words, non-migrants gave the first birth earlier than migrants. Figure 2.2(b) demonstrates the probability of being childless changes over age for the migrants and the non-migrants, which is estimated by the Kaplan-Meier approach (Kaplan and Meier, 1958), The curve for migrants lies above that for non-migrants everywhere over the entire age range, and the difference between the two curves increases at the beginning, peaks at age 25, remains at more than 3 percentage points until age 40. The pattern suggests that migration did not only delay the timing of the first birth, but also led to an increase in the probability of being childless.

2.4 Results and Discussion

2.4.1 Fertility Rate

The estimates of OLS and IV are shown in Table 2.2. The OLS estimates in the first column show that migration experience is significantly negatively correlated with the number of births a married rural woman experienced. Specifically, married rural women would give 0.10 fewer births than those who never migrated.[3] The estimations of the remaining control variables indicate that a higher education level leads to fewer births. The effect of the family planning policy is very significantly positive, and the magnitude is very close to one. Furthermore, the older the married woman, the more the children she has. In addition, married women from poor counties or townships, or poor households have more children; while those from cadre families have fewer children, perhaps because the cadre families have to strictly follow all the government's policies, including the family planning policy.

[3] The result of propensity score matching techniques confirmed that married rural women have -0.35(0.09) fewer children. However, the result suffers from the endogeneity problem too, and thus are not discussed in detail.

Table 2.2: The Effect of Rural-Urban Migration in China on the Number of Births, Females 16-45 Years

	Married sample			Full sample		
Variables	OLS	1st Stage	IV	OLS	1st Stage	IV
Ever migrated	-0.10***		-0.68	-0.10***		-0.81**
	(0.02)		(0.52)	(0.02)		(0.33)
Whether any extreme rainfall event occurred		0.04***			0.06***	
		(0.01)			(0.01)	
Whether married				0.86***	-0.04**	0.84***
				(0.02)	(0.00)	(0.03)
Birth order	-0.01	0.00	-0.01	-0.01**	0.00	-0.01**
	(0.01)	(0.00)	(0.01)	(0.01)	(0.00)	(0.01)
Minority status	-0.05	0.09	0.01	-0.02	0.09	0.04
	(0.14)	(0.09)	(0.15)	(0.12)	(0.09)	(0.14)
Schooling years	-0.01***	0.00*	-0.01**	-0.00	-0.01***	-0.01**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Age $<$ 20	0.04***	-0.02***	0.02	0.05***	-0.03***	0.03**
	(0.01)	(0.01)	(0.02)	(0.01)	(0.00)	(0.01)
Age 20 – 30	0.04***	-0.02***	0.03***	0.04***	-0.01***	0.03***
	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.01)

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	Married sample			Full sample		
Variables	OLS	1st Stage	IV	OLS	1st Stage	IV
Age > 30	0.05***	-0.02***	0.04***	0.05***	-0.02***	0.03***
	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.01)
From a cadre family	-0.08**	0.00	-0.08**	-0.06**	0.00	-0.06**
	(0.03)	(0.02)	(0.03)	(0.02)	(0.02)	(0.03)
Household income	0.02	0.00	0.02	0.02	0.05*	0.02
(10^5 RMB Yuan)	(0.05)	(0.04)	(0.06)	(0.04)	(0.03)	(0.05)
Terrain (reference group: Plains)						
Hills	0.06	-0.01	0.05	0.05*	0.00	0.05*
	(0.04)	(0.02)	(0.04)	(0.03)	(0.02)	(0.03)
Mountains	0.19***	0.03	0.21***	0.13***	0.05*	0.16***
	(0.05)	(0.03)	(0.05)	(0.04)	(0.03)	(0.04)
From a poor county	0.01	-0.02	-0.01	-0.00	-0.01	-0.01
or township	(0.04)	(0.03)	(0.04)	(0.03)	(0.02)	(0.03)
Fertility policy index	1.11***	0.09	0.03	0.77***	-0.28**	-0.03
	(0.24)	(0.16)	(0.40)	(0.18)	(0.14)	(0.28)
Constant	-1.97***	0.66***	0.21	-2.15***	1.33***	-0.26
	(0.36)	(0.23)	(1.01)	(0.27)	(0.20)	(0.67)

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	Married sample			Full sample		
Variables	OLS	1st Stage	IV	OLS	1st Stage	IV
County fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4,818	4,818	4,818	6,748	6,748	6,748
Adjusted R^2	0.41	0.24		0.66	0.25	
F-statistic for weak instruments		9.63			20.46	

Note: standard errors in parentheses; ***, **, and * denote significant at 1%, 5%, and 10% respectively; the results for the first stage regressions are shown in Table A.1.

As discussed previously, the OLS estimates are inconsistent because of the endogeneity problem. Thus, in the second column I report the IV results. The instrument is strong enough as the Cragg-Donald Wald F-statistic shows $F = 9.63$. It can be concluded that the maximal size of IV is less than 15% according to the critical values in Stock and Yogo (2005). Most of the second stage results of IV are quite similar to those of OLS in signs, magnitudes and significance. The main difference is that the effect of migration becomes very large, but insignificant.

It may be argued that the results are not reliable because the exclusion of unmarried women may lead to a selection problem. Thus, I include the unmarried females into the sample. The OLS and IV results of the full sample comprising both the married and the unmarried are shown in the last two columns of Table 2.2. Basically, the signs and magnitudes of estimations are quite similar to those of the married sample, of course after controlling the marriage status: the OLS estimates show that migration is modestly negatively correlated with fertility rate; while the IV results indicate that the effect of migration is quite large and significant.[4]

[4]It could be concerned that linear setting is not appropriate because the number of birth is between zero and two for most women. So, Poisson model is employed. The magnitude the estimated effect, -0.10**(0.04), is also very close to the OLS results, -0.10***(0.02). However, the estimate of an instrumental variables Poisson regression did not converge. Since both the simple OLS and Poisson suffer from the problem of endogeneity, the IV results is the focus of this study.

It may be concerned that the standard errors of IV could be underestimated because of the correlation across individuals from the same county which is . So, a Pagan-Hall test (Pagan and Hall, 1983) is employed to examine whether the heteroskedasticity caused by the counties is significant. The results ($\chi(79)^2 = 0.862$ for the full sample and $\chi(79)^2 = 0.149$ for the married sample) indicate that the heteroskedasticity is insignificant and the IV estimates' standard errors are not clustered at the county level.

It may also be concerned that IV estimate is much smaller than that of OLS. One reason, as mention previously, is that the OLS suffers from the endogeneity problem. The other possible reason is that the IV approach identifies a Local Average Treatment Effect (LATE) (Imbens and Angrist, 1994) rather than an average Treatment effect. In the same paper, Imbens and Angrist defined compliers as the observations whose treatment status can be manipulated by an instrumental variable. And the effect identified by IV approach is the average treatment effect for this special group. In this study, women who migrated because of extreme rainfall events are compliers. So, comparing the results of OLS and IV directly is meaningless. The effect of migration on the number of births for compliers (the results of IV) is much larger because the rainfall events were randomly and migration caused by these events cannot be anticipated by compliers. And their original fertility plan could be significantly interrupted by the sudden migration: giving births could be delayed and so the number of births in their whole lives could be reduced. Whereas, for those who always migrate whether rainfall events happen or not, the effect could be much less because migration is already taken into account and their numbers of births would not alter.

It can also been seen that the instrumental variable becomes much stronger after the introduction of unmarried women. The F-statistics is more than 20 which means the maximal size of IV is less than 10%. The introduction of the unmarried women deals with the selection problem; however, it adds another possibly endogenous variable - marriage status - into the regressions, because besides fertility behaviour and migration decisions, the unobserved career ambitions can also affect the marriage decision. The problem is not solved in this study, because there is only one valid instrumental variable available.

As mentioned previously, the fertility rate and the occurrence of extreme weather events may be mechanically correlated. On the one hand, women age more than 25 are more likely to experience extreme weather events than women aged less than 25 because the former have longer time span exposing to extreme weather events. On the other hand, obviously older women have more children than younger women. The age distribution of the first birth in Figure 2.3 based on data from RUMiCI (Wave 1) suggests more than 80% women have given at least one birth at age 25. Thus, there may be a mechanic correlation between the instrumental variable and the dependent variable. In order to test this possibility, I conduct two

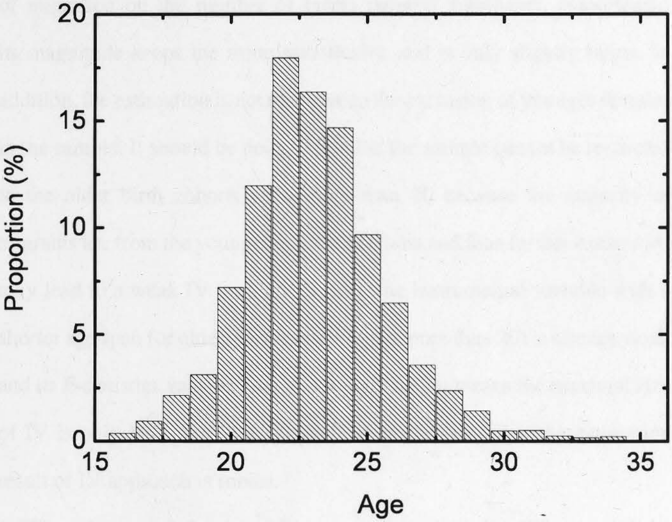

Figure 2.3: The Age Distribution of the First Birth in Rural China, Females 16-45 Years, 2008, RUMiCI

robustness checks. The first one is to restrict the age interval exposure to extreme weather events to 16 to 22 years. By reducing three years in the age span of the instruments, only about 40% women who have given at least one birth at age 22 (see Figure 2.3). The second one is to exclude the young females from the sample. Both of the measures try to reduce the possible mechanic correlation between the occurrence of extreme weather events and the fertility behaviours. The results are show in Table 2.3. Using the instrumental variable with shorter age span leads that the effect of migration on the number of births remains significant. Importantly, its magnitude keeps the same statistically, and is only slightly larger. In addition, the estimation is not sensitive to the exclusion of younger females in the sample. It should be pointed out that the sample cannot be restricted to the older birth cohorts aged more than 20 because the majority of migrants are from the younger cohorts in China and thus further exclusions may lead to a weak IV problem. In fact, the instrumental variable with a shorter age span for oldest birth cohort (aged more than 20) is already weak and its F-statistics value is only about eight which means the maximal size of IV is only less than 20%. Overall, it can be seen that the estimation result of IV approach is robust.

The estimates of the age splines are not statistically different and the other alternative - controlling age and its quadratic term - seems to be reasonable. Furthermore, the assumption that the effect of schooling year is linear could be argued to be too restrictive. Thus, I conduct a robustness check by controlling age and its quadratic term and introducing a series of binary variables indicating the education attainment (primary, secondary and tertiary education). The results in Table 2.4 show that the changes in the specification do not alter the conclusion - rural-urban migration decreased the fertility rate of rural women.

It should be noted that women with incomplete fertility are included in the regressions. So, the effect of migration identified in this chapter is that on the current fertility rate rather than the complete fertility rate. It

Table 2.3: The Robustness Checks - the Validity of the Instrumental Variable

Birth cohort	16-45 Full Sample	18-45	20-45
The age span of the instrumental variable: 16-25 years			
Ever migrated	-0.81**	-0.81**	-0.82**
	(0.33)	(0.35)	(0.41)
F-statistic for weak instruments	20.46	19.12	14.64
The age span of the instrumental variable: 16-22 years			
Ever migrated	-0.98**	-1.01**	-1.07*
	(0.45)	(0.49)	(0.59)
F-statistic for weak instruments	12.42	11.11	8.19
Observations	6,748	6,605	6,077

Note: standard errors in parentheses; ***, **, and * denote significant at 1%, 5%, and 10% respectively; the full results and the results for the first stage regressions are shown in Table A.2 and Table A.1 respectively.

is possible that rural women only decide to postpone the timing of births without changing the number births. In other words, the effect identified is only a tempo effect. However, because of rural women's planned number of children is not available, this assumption cannot be examined. However, the effect of migration on the complete fertility would be in the same direction as that on the current fertility because the span of fertility is shortened and correspondingly women would have fewer children. In order to show this point, I conduct a robustness check by estimating the effect

Table 2.4: The Robustness Checks - Specifications, Females

	Married sample		Full sample	
Variables	OLS	IV	OLS	IV
Ever migrated	-0.11***	-0.86	-0.10***	-1.01***
	(0.02)	(0.56)	(0.02)	(0.40)
Educational attainment (reference group: Illiteracy)				
Primary education	-0.06**	-0.03	-0.10***	-0.02
	(0.03)	(0.04)	(0.02)	(0.04)
Secondary education	-0.08***	-0.04	-0.10***	-0.04
	(0.03)	(0.04)	(0.02)	(0.04)
Tertiary or higher education	-0.08**	-0.01**	-0.04	-0.17**
	(0.05)	(0.06)	(0.03)	(0.07)
Age	0.10***	0.10***	0.01	0.08**
	(0.01)	(0.02)	(0.01)	(0.03)
Age square/100	-0.07***	-0.09***	-0.06***	-0.07***
	(0.02)	(0.03)	(0.01)	(0.05)
Observations	4,818	4,818	6,748	6,748
Adjusted R^2	0.41		0.66	
F-statistic for weak instruments		9.14		16.77

Note: standard errors in parentheses; ***, **, and * denote significant at 1%, 5%, and 10% respectively; other controls not shown.

of migration among women whose fertility cycles are completed (see Table 2.5). The OLS estimates show that the difference in the number of births between migrants and non-migrants reduces but remains significant when the sample is restricted to the women between the ages of 35 and

Table 2.5: The Robustness Checks - Older Birth Cohorts, Females, OLS

Birth cohort	16-45 Full Sample	35-45	40-45
Ever migrated	-0.10***	-0.07**	-0.07*
	(0.02)	(0.03)	(0.04)
Observations	6,748	2,926	1,785
Adjusted R^2	0.41	0.42	0.46

Note: standard errors in parentheses; ***, **, and * denote significant at 1%, 5%, and 10% respectively; full results are shown in Table A.3.

45 years or of 40 and 45 years.[5] There are two possible reasons to the small increase in the OLS estimate. One is that migration may have a postponement effect on the timing of births. Thus, when women complete their fertility, the difference in the number of births between migrants and non-migrants will be reduced. It may also be because of the birth cohort effect. That is, among younger women, the difference in the fertility between migrants and non-migrants is larger. Unfortunately, the analysis based on cross-sectional data cannot distinguish these two effects from each other. However, The duration analysis in next subsection can solve this problem.

[5]The IV estimates for women from old birth cohorts are not reported because the instrumental variable is not strong enough

2.4.2 Timing of the First Birth

The estimation results of the duration models on timing of the first birth are shown in Table 2.6. The hazard ratios are reported. The results for the married sample are reported in the columns 1 (assuming age starting school as six) and 2 (assuming age starting school as eight). It can be seen that the estimation results are not sensitive to the assumption of the enrolment age. Education, measured by schooling years in this study, and enrolment at school postpone the timing of the first birth significantly. Women from mountainous areas are younger at the age of first birth. The baseline hazard increases with age.

The estimation also shows that the correlation between rural-urban migration and the timing of the first birth is insignificant among married sample. When unmarried women are included in the sample, the results changed. The results of the full sample are shown in the third and fourth columns of Table 2.6. There are two major changes. First, the effect of migration becomes very significant. The hazard rate at which a female rural-urban migrant gives birth is 24% $(1 - 0.76)$ to 27% $(1 - 0.73)$ less than that of a similar female non-migrant. Combining the fact that there is no effect among the married females, these findings suggest that female migrants likely postpone their marriages, and delay the timing of their first births. In order to demonstrate this point, I introduce a time-variant variable indicating whether a female is married or not. The variable changes from

Table 2.6: The Effect of Rural-Urban Migration in China on the Timing of the First Birth, Females 16-45 Years

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Married restricted sample		Full restricted sample					
Variables	Enroled at age 6	Enroled at age 8	Enroled at age 6	Enroled at age 8	Enroled at age 6	Enroled at age 8	Enroled at age 6	Enroled at age 8
Whether migrated	0.92	0.90*	0.76***	0.73***	0.99	0.98		
	(0.06)	(0.05)	(0.05)	(0.04)	(0.06)	(0.06)		
Migration × Born before 1970							1.09	1.09
							(0.14)	(0.14)
Migration × Born in the 1970s							0.76***	0.75***
							(0.05)	(0.05)
Migration × Born after 1980							0.64***	0.60***
							(0.06)	(0.05)
Whether married					104.58***	81.45***		
					(11.50)	(8.96)		
Birth order	1.00	1.00	1.01	1.01	1.00	1.00	1.01	1.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Minority status	0.79	0.82	0.86	0.89	1.14	1.15	0.84	0.88
	(0.21)	(0.22)	(0.23)	(0.24)	(0.31)	(0.31)	(0.24)	(0.25)

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	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Married restricted sample		Full restricted sample					
Variables	Enroled at age 6	Enroled at age 8	Enroled at age 6	Enroled at age 8	Enroled at age 6	Enroled at age 8	Enroled at age 6	Enroled at age 8
Schooling years	0.98***	0.99*	0.97***	0.98***	0.99*	0.99	0.97***	0.98***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Enrolment	0.34***	0.10***	0.15***	0.08***	0.31***	0.17***	0.15***	0.08***
	(0.14)	(0.02)	(0.06)	(0.02)	(0.13)	(0.04)	(0.06)	(0.02)
From a poor county	1.06	1.06	1.11	1.09	1.13	1.12	1.11	1.11
or township	(0.07)	(0.07)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)
Terrain (reference group: Plains)								
Hills	1.09	1.09	1.08	1.07	1.05	1.05	1.08	1.08
	(0.08)	(0.08)	(0.08)	(0.08)	(0.07)	(0.07)	(0.08)	(0.08)
Mountain	1.34***	1.32***	1.25**	1.25**	1.16	1.16	1.25**	1.25**
	(0.12)	(0.12)	(0.11)	(0.11)	(0.10)	(0.10)	(0.11)	(0.11)
Generation (reference Group: Born before 1970)								
Born in the 1970s	0.94	0.95	0.90***	0.91**	1.02	1.03	0.91**	0.92**
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Born after 1980	0.99	1.02	0.49***	0.52***	0.88**	0.89**	0.54***	0.58***
	(0.06)	(0.06)	(0.03)	(0.03)	(0.05)	(0.05)	(0.04)	(0.04)

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	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Married restricted sample		Full restricted sample					
Variables	Enroled at age 6	Enroled at age 8	Enroled at age 6	Enroled at age 8	Enroled at age 6	Enroled at age 8	Enroled at age 6	Enroled at age 8
Baseline								
h_{01} (Age 16-19)	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
h_{02} (Age 20)	0.08***	0.07***	0.08***	0.08***	0.00***	0.00***	0.08***	0.08***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)	(0.01)
h_{03} (Age 21)	0.14***	0.13***	0.16***	0.15***	0.00***	0.00***	0.16***	0.14***
	(0.02)	(0.02)	(0.03)	(0.02)	(0.00)	(0.00)	(0.03)	(0.02)
h_{04} (Age 22)	0.26***	0.24***	0.29***	0.27***	0.00***	0.01***	0.29***	0.26***
	(0.04)	(0.04)	(0.04)	(0.04)	(0.00)	(0.00)	(0.04)	(0.04)
h_{05} (Age 23)	0.31***	0.29***	0.35***	0.32***	0.00***	0.01***	0.35***	0.32***
	(0.05)	(0.04)	(0.05)	(0.05)	(0.00)	(0.00)	(0.05)	(0.05)
h_{06} (Age 24)	0.40***	0.37***	0.45***	0.41***	0.00***	0.01***	0.44***	0.41***
	(0.06)	(0.06)	(0.07)	(0.06)	(0.00)	(0.00)	(0.07)	(0.06)
h_{07} (Age 25)	0.43***	0.39***	0.47***	0.43***	0.00***	0.01***	0.47***	0.43***
	(0.07)	(0.06)	(0.08)	(0.07)	(0.00)	(0.00)	(0.07)	(0.07)

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	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Married restricted sample		Full restricted sample					
Variables	Enroled at age 6	Enroled at age 8	Enroled at age 6	Enroled at age 8	Enroled at age 6	Enroled at age 8	Enroled at age 6	Enroled at age 8
h_{08} (Age 26)	0.45***	0.41***	0.49***	0.45***	0.00***	0.01***	0.49***	0.44***
	(0.07)	(0.07)	(0.08)	(0.07)	(0.00)	(0.00)	(0.08)	(0.07)
h_{09} (Age 27)	0.43***	0.40***	0.46***	0.42***	0.00***	0.01***	0.45***	0.41***
	(0.07)	(0.07)	(0.08)	(0.07)	(0.00)	(0.00)	(0.08)	(0.07)
h_{10} (Age 28)	0.44***	0.41***	0.45***	0.42***	0.00***	0.01***	0.45***	0.41***
	(0.08)	(0.07)	(0.08)	(0.08)	(0.00)	(0.00)	(0.08)	(0.07)
h_{11} (Age 29)	0.40***	0.38***	0.38***	0.35***	0.00***	0.00***	0.38***	0.34***
	(0.08)	(0.08)	(0.08)	(0.07)	(0.00)	(0.00)	(0.08)	(0.07)
h_{12} (Age 30)	0.24***	0.22***	0.22***	0.20***	0.00***	0.00***	0.21***	0.20***
	(0.06)	(0.06)	(0.06)	(0.05)	(0.00)	(0.00)	(0.06)	(0.05)
h_{13} (Age 31+)	0.24***	0.22***	0.21***	0.19***	0.00***	0.00***	0.20***	0.19***
	(0.05)	(0.04)	(0.04)	(0.04)	(0.00)	(0.00)	(0.04)	(0.04)
County Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of rural women	3,840	3,840	5,770	5,770	5,770	5,770	5,770	5,770
Log-Likelihood	1,913.78	1,989.98	1,385.55	1,476.20	3,876.05	3,908.67	1390.70	1482.70

Note: Hazard ratios are reported; standard errors in parentheses; ***, **, and * denote significant at 1%, 5%, and 10% respectively.

zero to one once a female marries for the first time and keeps to be one. The estimates are shown in columns (5) and (6) of Table 2.6. The hazard of first birth boom after females marry because a serious social stigma is attached to out-of-wedlock births and females tend to give births after marriage in China. At the same time, the effect of migration on the timing of the first birth disappears. Without controlling the marriage status, the effect of migration on the timing of the first birth in fact is a combination of the effect of migration on the age of the first marriage and that on the interval between the marriage and the first birth. So, after eliminating the former out of the overall effect, migration seems to be weakly correlated with the timing of the first birth. Again, the reason is that the delay in female migrants' first birth mainly is caused by the postponement of their marriages. Next chapter investigates the effect of rural-urban migration on the timing of marriage in detail.

The second major changes in the estimation results of the married sample and the full sample is that the effect of birth cohorts is very significant. Comparing with the rural women who were born before 1970, the hazard of the first birth for those who were born in the 1970s was reduced by about 33% (i.e. 1.09-0.76 or 1.09-0.75); for the women who were born after 1980, the hazard of the first birth is further reduced by more than 10%. The reason could be that those born in the 1970s and 1980s, particularly the latter, is a very special group in modern China. As Elegant (2007) pointed out, Post-1980 is a hybrid generation conciliating western culture and Chinese tradition. Post-1980 claim that they only live for themselves, and are not willing to take on many responsibilities. However, according to the traditional patriarchal attitudes, the main responsibility of a daughter-in-law is to take care not only the elderly, children, but also the whole family (Wolf, 1972, 1985). As a result, Post-1980 females are very likely to postpone the timing of marriage in order to reduce their responsibility, and therefore the hazard of the first birth for Post-1980 could be lower than that of old birth cohorts.

It should be noted that when discussing the difference in women from various birth cohorts, I try to compare a woman from the Post-1980 birth cohort with another woman from older birth cohorts when they are at the same age. In order to verify this deduction, I employ the Kaplan-Meier approach to estimate how the probability of being childless changes over age for females from various birth cohorts (see Figure 2.4 (a)). The figure shows that the gap between the curves for females from Pre-1970 and Post-1970 is very small, however. The decrease in the curve for females from Post-1980 is much slower that that of the other cohorts. It is indicated that Post-1980 females have their first children much later than the older cohorts. Furthermore, out-of-wedlock births are attached to a very serious stigma in China, thus there may be a mechanism that females from Post-1980 cohort tend to keep unmarried and hence to be childless. In Figure 2.4 (b), the curves of the probability of being unmarried for females from various birth cohorts are presented. Women from Post-1980 birth cohort

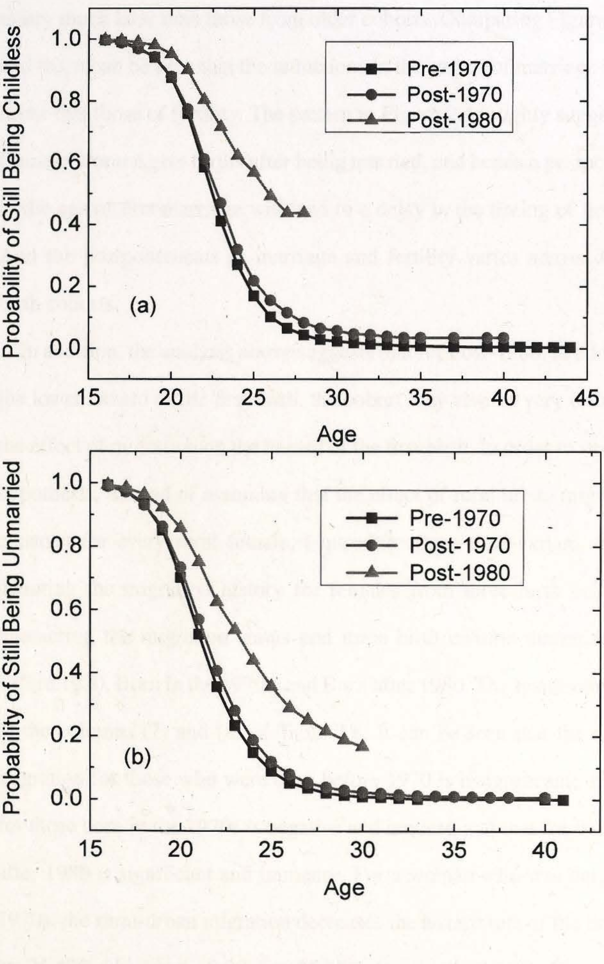

Figure 2.4: Probability of Still Being Childless or Unmarried in China for Females from Various Birth Cohorts

marry much later than those from older cohorts. Comparing Figure 2.4 (a) and (b), it can be seen that the reductions in the curves of marriage is much faster that those of fertility. The pattern in Figure 2.4 roughly suggests that Chinese women give births after being married, and hence a postponement in the age of first marriage will lead to a delay in the timing of first birth. And the postponements in marriage and fertility varies across different birth cohorts.

In addition, the analysis above suggests that for Post-1980, in addition to the lower hazard of the first birth, the cohort may also be very different in the effect of migration on the hazard of the first birth. In order to verify this hypothesis, instead of assuming that the effect of rural urban migration is constant for every rural female, I introduce three time-variant variables denoting the migration history for females from three birth cohorts by interacting the migration status and three birth cohorts dummies: Born before 1970, Born in the 1970s, and Born after 1980. The results are shown in the columns (7) and (8) of Table 2.6. It can be seen that the effect of migration for those who were born before 1970 is insignificant; the effect for those born in the 1970s is negative and modest; and that for those born after 1980 is significant and immense. For a woman who was born in the 1970s, the rural-urban migration decreases the hazard rate of the first birth by 24.42% $(1-\exp(-0.28))$ to 25.17% $(1-\exp(-0.29))$. However, for those who were born after 1980, the effect of migration is very large and significant: a reduction between 35.60% $(1-\exp(-0.44))$ and 39.95% $(1-\exp(-0.51))$ in the hazard rate of the first birth.

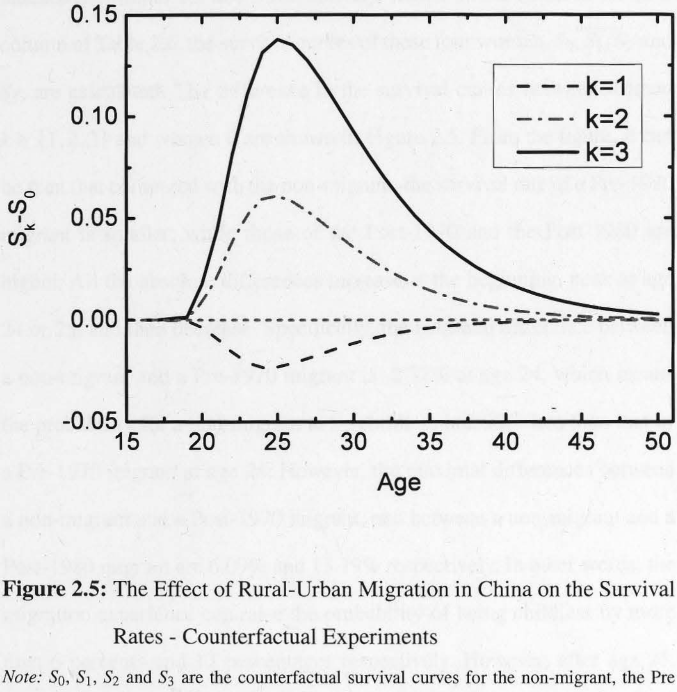

Figure 2.5: The Effect of Rural-Urban Migration in China on the Survival Rates - Counterfactual Experiments

Note: S_0, S_1, S_2 and S_3 are the counterfactual survival curves for the non-migrant, the Pre 1970 migrant, the Post-1970 migrant and the Post-1980 migrant respectively.

In order to show the effect of migration on the timing of the first birth, I conduct counterfactual experiments. Assume there are four identical women ($k \in \{0,1,2,3\}$) whose characteristics are the same as the mean of the full restricted sample. One of them is a non-migrant indexed as woman 0; while the other three are assumed to migrate at age 18, to come from three birth cohorts (before 1970, in the 1970s and after 1980) and are indexed as woman 1,2 and 3 respectively. Based on the result in the fifth column of Table 2.6, the survival curves of these four women, S_0, S_1, S_2 and S_3, are calculated. The difference in the survival curves between women $k \in \{1,2,3\}$ and women 0 are shown in Figure 2.5. From the figure, it can be seen that compared with the non-migrant, the survival rate of a Pre-1970 migrant is smaller; while those of the Post-1970 and the Post-1980 are higher. All the absolute differences increase at the beginning, peak at age 24 or 25, and then decrease. Specifically, the maximal difference between a non-migrant and a Pre-1970 migrant is -2.32% at age 24, which means the probability for a non-migrant to be childless is 2.32% less than that of a Pre-1970 migrant at age 24. However, the maximal differences between a non-migrant and a Post-1970 migrant, and between a non-migrant and a Post-1980 migrant are 6.09% and 13.79% respectively. In other words, the migration experience can raise the probability of being childless by more than 6 percents and 13 percentages respectively. However, after age 25, the effect of migration starts to fade out and after age 40, the effects of migration on the timing of motherhood for all the migrants from different birth cohorts becomes very slight. In addition, based on the survival curves, the expected age of the first birth can be calculated. For a non-migrant, the expected age of the first birth is 24.65 years; the expected age for a Pre-1970 migrant is almost the same - 24.43 years. The postponement effect of migration is very significant for both the Post-1970 and Post-1980 - migration delays the first birth by 7.43 and 17.73 months respectively compared with a similar non-migrants. And because the estimation of the effect of migration for Post-1970 is almost the same as that for the whole population, the rural-urban migration also delays the first birth by about 7 months for all the women. In addition, considering that the effect of rural-urban migration on fertility behaviour is quite large according to IV estimated, migration should postpone the second and third births significantly rather than the first birth.

Finally, in order to investigate the robustness of the results, I perform two sensitivity tests. The first one investigates the effect of ignoring the unobserved heterogeneity in this issue. It is widely accepted that ignoring unobserved heterogeneity in the hazard model may bias the estimation of the effect of observed explanatory variables (van den Berg, 2001). So, I investigate this issue by assuming the distribution of heterogeneity follows 1) an inverse-Gaussian distribution, 2) a gamma distribution and 3) a two-point distribution. The estimation of the first setting show that the gamma distribution degenerates into a single-point distribution and thus all the estimates are identical to those of a hazard model ignoring the unobserved heterogeneity. When the distribution of heterogeneity is assume to be inverse-Gaussian, the estimation failed to converge. Finally, if a two-point distribution is assumed, estimations show that these two points cannot be

Table 2.7: The Effect of Pre-Migration on the Timing of the First Birth in China, 5770 Females 16-45 Years

Variable	Enroled at age 6	Enroled at age 8	Enroled at age 6	Enroled at age 8	Enroled at age 6	Enroled at age 8	Enroled at age 6	Enroled at age 8
The n^{th} year before migration								
$n=5$	-0.20	-0.18	-0.23*	-0.21				
	(0.14)	(0.14)	(0.14)	(0.14)				
$n=4$	0.10	0.12	0.08	0.10				
	(0.13)	(0.13)	(0.13)	(0.13)				
$n=3$	-0.24	-0.24	-0.25	-0.25				
	(0.16)	(0.16)	(0.16)	(0.16)				
$n=2$	-0.17	-0.16	-0.18	-0.16				
	(0.17)	(0.17)	(0.17)	(0.17)				
$n=1$	-0.22	-0.20	-0.23	-0.20				
	(0.18)	(0.18)	(0.18)	(0.18)				
All five years					-0.13*	-0.11	-0.15**	-0.13*
					(0.07)	(0.07)	(0.07)	(0.07)
Migrated	-0.30***	-0.33***			-0.31***	-0.33***		
	(0.06)	(0.06)			(0.06)	(0.06)		
Migrated × Born before 1970			0.08	0.08			0.08	0.08
			(0.13)	(0.13)			(0.13)	(0.13)
Migrated × Born in the 1970s			-0.30***	-0.31***			-0.30***	-0.31***
			(0.08)	(0.08)			(0.08)	(0.08)
Migrated × Born after 1980			-0.47***	-0.53***			-0.47***	-0.53***
			(0.09)	(0.09)			(0.09)	(0.09)
Log-likelihood	1,389.43	1,479.74	1,394.97	1,486.58	1387.23	1477.44	1392.82	1484.3452

distinguished from each other. Thus, all the tests suggest ignoring the unobserved heterogeneity may not result in bias in this study.

The second test examines whether rural-urban migration affects the timing of the first birth even before migration starts. It is reasonable to assume that some females make the decisions of migration and fertility simultaneously. In other words, the hazard of the first birth has already changed even before the migration is realized. However, in previous models, it is assumed that the hazard does not change until the start of migration. Thus, I attempt to capture the effect of pre-migration - the effect of migration before the migration really occurs - by introducing five dummy variables indicating each of the five years before migration. In other words, the treatment of migration is assumed to have started several years before migration. The estimation results of the augmented duration model for the full restricted sample are shown in first four columns of Table 2.7. It can be seen that all the estimations for the effect of pre-migration are insignificant except that of the fifth year before migration and this is only marginally significant. Then, the joint significance of all the variable indicating re-migration status is tested. The result, $\chi^2(5) = 7.40$, suggests that these five variables are not jointly significant. So, based on these five variables, I gauged a new binary variable for all five years before migration. The introduction of this new variable does not change the estimates (see last four columns of Table 2.7).Thus, the results of this study are not sensitive to the assumption whether or not rural-urban migration takes effect before the start of migration.

2.5 Conclusion

In this chapter, I analyse the effect of migration on the fertility behaviour of married women in rural China from two aspects - the fertility rate and the timing of the first birth. In order to deal with the endogeneity problem, I employed a dummy variable indicating whether any extreme rainfall event happened when the female was aged between 16 and 25 as the instrument for migration decisions. The results show that rural-urban migration significantly reduces the number of births for migrants who migrate as a result of extreme rainfall events. After migration, the fertility of a rural woman in China decreases by 0.81. The effect of migration is very large, compared with the average fertility of all married females in the data used - 1.63 children.

Besides the fertility rate, I also investigate the association between the timing of migration and the timing of the first birth by using a piece-wise constant proportional hazard model. The results show that the correlation between migration and the timing of the first birth among the married females is very weak; however migration is significantly negatively correlated with the timing of motherhood once unmarried women are included. These findings suggest that the migration postpones motherhood by deferring marriage. Counterfactual experiments reveal that migrants give the first birth about 7 months later than non-migrants. Furthermore, it is demonstrated that women in the younger birth cohort - Post-1980, the first birth occurs much later and the effect of migration for them is also much larger than for those from the other mature birth cohorts.

Chapter 3

Does Rural-Urban Migration Delay the First Marriage in Rural China?

Abstract This study investigates the correlation between the timing of the first marriage and rural-urban migration behaviour. The estimation results of a bivariate mixed proportional hazard model show that rural-urban migration is associated with an increase of 18.53% in the annual hazard rate of the first marriage for rural males, but an decrease of 24.09% for rural females in China. The counterfactual experiments show that the change in the first marriage age associated with migration behaviour is limited: on average, male migrants marry four months earlier than similar male non-migrants, while female migrants marry four months later than female similar non-migrants. However, the difference in the marriage rate between migrants and non-migrants for individuals age between 22 and 28 is quite large. And a detailed analysis shows that the difference between male migrants and male non-migrants in the first marriage age is mainly due to the duration of migration; while, for females, the effect of the birth cohort is the essential reason for delaying the first marriage.

Key words: Rural-urban migrant; Timing of first marriage; China

3.1 Introduction

Delays in the age of the first marriage, both historically in developed countries and currently in developing countries, are of interest to demographers and economists (see e.g. Bloom and Reddy, 1986; Coale and Treadway, 1986; Goldstein and Kenney, 2001; Gustafsson, 2001; Mensch et al., 2005). On the one hand, women who marry late will have a short reproductive span which often affects the complete fertility on average (Kohler et al., 2002; Lutz and Skirbekk, 2005; Morgan and Rindfuss, 1999). A number of studies demonstrate that the variance in the age of the first marriage is associated with the difference in fertility across populations and also the trends in fertility within populations over time (Department of International Economic and Social Affairs, United Nations, 1990; Jones and Gubhaju, 2009). Also as suggested by Becker (1973), the timing of marriage relates to economic issues. For example, delays in marriage are often correlated with the increase in females' education level, and female labour force participation.

Literature show that changes in the average marriage age are always accompanied by major social-structural changes such as increases in education attainment, improvements of the status of women, and urbanization processes (Kaufman and Meekers, 1998; United Nations, 1987, 1988).

Among these major changes, migration however may affect marital timing in two contradictory ways. Firstly, migration may delay marriage because it does not only relocate individuals outside of local marriage markets, but also leads to a period of adjustment to the considerable economic uncertainty in destinations (see e.g. Chattopadhyay, 1999). Alternatively, as shown by studies, experience in cities could accelerate marriage because of migration's positive economic effects for the household economy. For example, Parrado (1998) demonstrated that the migration to the United States of Mexican men accumulate financial resources to meet the requirement of marriage and may facilitate the formation of marriages after migrants returns home. Although this is an example of international migration, the international migration theories were developed to explain the relationship between rural-urban migration and marriages in developing countries (see e.g. Massey et al., 1993). To the best of my knowledge, little effort has gone into investigating the correlation between the timing of the first marriage and rural-urban migration in China which is the recent and significant social-structural change in the developing world (Brockerhoff, 1995; Lall et al., 2006; Meng et al., 2010). As suggested by Ding and Meng (2011), in China, migrants postpone the timing of the first birth. It is interesting to know to what extent this is due to the delayed the first marriage. Thus, this study examines the correlation between the timing of the first marriage and migration behaviour in rural China.

The migration may affect the timing of the first marriage for a number of reasons. First, after migration, migrants have to face an unfamiliar marriage market and limited social networks, hence it takes them much longer to find mates. Second, migrants work long hours (Du et al., 2006) and have limited energy and time to search for a mate in cities. Third, the effect of migration may depend on the availability of a mate for migrants in cities. On the one hand, in China, rural-urban migrants are discriminated against because they are less educated, usually have manual jobs and earn much less compared with urban residents (Meng and Zhang, 2001; Zhang et al., 2011). Hence it is less likely for rural-urban migrants to find partners among urban local people. On the other hand, this phenomenon can lead to more marriage within migrants which has been documented by Zhang (2009). Fourth, migration experience may open migrants' minds, change their preference with respect to marriages, and alter the timing of marriage. Fifth, migration experience may be a signal of the searcher's quality in a marriage market. Migrants are normally regarded as rich compared with non-migrants in rural areas because they earn more in cities (Du et al., 2005), and they are also considered as able because they are richer in life experience, especially with regard to urban experience and non-farm work skills (Zhao, 1999). However, the signalling effect of migration may be gendered different if the tasks considered appropriate by society for males and females are not the same. Finally, literature suggests that most unmarried women return to their villages to marry and bear children, and never migrate again because women are supposed to take care of the family according to Chinese traditional culture (Davin, 1999; Du, 2000; Fan, 2004; Jacka, 1997), although recently some women started to migrating after marriage and births of children (Roberts et al., 2004). As a result, marriage may be delayed if women plan to migrate. Overall, the effect of rural-urban migration on the timing of the first marriage is ambiguous.

In order to examine the extent to which rural-urban migration affects the timing of the first marriage in China, I use the first and the third waves of the Chinese Rural Household Survey data from the Rural-Urban Migration in China and Indonesia (RUMiCI) project because the information on which year men migrated from rural areas to urban areas for the first time and on which year they returned was collected in the first and third wave respectively. There are three problems need to be dealt with when identifying the effect of migration. The first is the censored observation problem which is result from the fact that there are many individuals in the sample still unmarried when the survey was conducted but who will marry in the future. The second is the selection problem caused by the unobserved heterogeneity. Many unobserved factors, for example career ambitiousness, can affect both decisions of migration and marriage, so individuals with high unobserved random components are more likely to experience the event of interest early. As a result, the effects of the explanatory variables on the hazard of interest is underestimated. The third one is the reverse causality problem. That is, rural-urban migration can affect the timing of marriage, whereas, the timing of marriage can impact on the rural-urban migration decision reversely. A bivariate mixed proportional hazard model is employed to solve these three problems. However, there is an implicit assumption for this econometric model, the *No Anticipation* assumption, which must be satisfied (Jaap et al., 2005). It is assumed that individuals have no access to information on the timing of treatment or simply do not act on such information. In this study, this assumption is violated, because individuals may anticipate the exact timing of migration and then adjust the plan of marriage accordingly. So, the relationship identified in this study is not a causality but an association relationship although the censored observation, selection effect and reverse causality problems are solved.

The estimates show that rural-urban migration is significantly associated with the timing of the first marriage. Counterfactual experiments show that on average the male migrants marry four months earlier than similar male non-migrants, while female migrants marry four months later than similar female non-migrants. However, the correlation between migration decisions and marriage rates is quite large. For those aged between 22 and 28, the difference in the marriage rate between migrants and non-migrants keep around 5% whether for females or males. A more detailed analysis on the heterogeneity in the effect of rural-urban migration shows that the longer males stay in cities, the larger the probability of the first marriage for males. In contrast, for the females, the delay of the first marriage caused by rural-urban migration is mainly due to the birth cohort effect, not the time elapsing since the first migration.

The chapter is structured as follows. The next section introduces marriage regulations, which is helpful to understand the marriage behaviour of Chinese rural males and females. Section 3.3 and Section 3.4 present the data and the econometric methodology used in the study respectively. Section 3.5 discusses the empirical results, their robustness, and the heterogeneity of the migration effect and Section 3.6 concludes.

3.2 Marriage Regulation in China

The first Chinese Marriage Law, which went into effect in 1950, stipulated that the legal marriage ages for females and males are 18 and 20 years respectively; however in the 1970s, a series of family planning policies increased the ages for marriage to 23 and 25 years for women and men respectively in the rural areas, and even later for their urban counterparts although the marriage ages under the Marriage law remained the same (Chen and Zhen, 1981; Tien, 1975). When two people wish to marry, they first need to obtain approval from their respective employers or the heads of a rural communes; otherwise they will not be issued a marriage certificate. One necessary condition for the approval is that they are old enough according to the family planning policies. As a result, there were arguments that the legal marriage ages in the Marriage Law should be revised upwards and be consistent with the family planning policies. However, the fear that this may increase the incidence of cohabitation and births out of wedlock stopped the revision of the Marriage Law. It was not until 1981 that the Marriage Law was revised and the new law stipulated the legal minimum marriage ages are 20 and 22 years for females and males respectively. Although the legal marriage ages are not the same as those in family planning policies, they are still unusually high and seldom exceeded by other countries.

Marriages earlier than the legal marriage ages can be found in rural areas (Li, 1993; Lv, 2010). The two families of a young couple can gain social recognition by inviting family members and friends to a wedding. After both of the couple reach the legal age, they can obtain a marriage certificate from the government. The births from such marriages before official registration are fined, and the amount varies across regions and time, but is normally much lower than the fine for births above quota according to the family planning regulations, and thus more affordable to rural households. Taking Shandong, which is the second most populous province in China (95 million in 2010) (National Bureau of Statistics of China, 2011), as an example, the fine is twice of the annual per capita net income of rural residents in their localities if they marry before the legal marriage ages and have a child before the legal marriage ages, whereas, the fine for a birth out-of-quota is four to eight times of the annual per capita net income (Standing Committee of the Shandong Provincial People's

Congress, 2002). Although early marriage can be found in rural China, research shows that the age of the first marriage for females had gradually increased from about 22.0 to 23.6 between 1985 and 2005 (Chen, 2008).

Since the early 1950s, China has followed a household registration system known as *Hukou*, which separates China into rural and urban parts (Standing Committee of the National People's Congress, 1958). Residents are tied to the place where they were born, and their *Hukou* status, whether rural or urban, determines their entitlements, such as education, job opportunity, health care and retirement benefits and so on. Normally, the level of welfare and public service in cities is much higher than that in rural areas. However, the related regulations stipulate that rural people cannot obtain the urban *Hukou* via marriage to enjoy the higher level of welfare in cities. In other words, when marrying a rural partner, an urban person has to accept that his or her partner cannot work, go to hospital or have retirement benefits in cities. The situation is even worse if it is the husband who holds the urban *Hukou*, as his children's *Hukou* status has to follow their rural mother. Hence, his child(ren) may not enrol in a urban kindergarten or school where the quality is normally much higher than that of those in the countryside. In such circumstances, marriages between rural and urban citizens are very rare, while marriages between rural females from poor areas and rural males from rich areas are common.

It was not until 1998 that the Chinese State Council approved four guidelines aiming at solving critical problems in the practice of the *Hukou* system. The most significant changes are that rural spouses can obtain the urban *Hukou* after staying with their urban partners for some years, and children can inherit *Hukou* status from either of their parents upon birth. However, in practice, it is still almost impossible for rural *Hukou* holders to obtain the urban *Hukou* and to enjoy urban social welfare and public services. Rural residents are still discriminated against in the marriage market by urban residents and can only search for mates in the rural marriage market.

3.3 Data

The data used in this chapter is from the Rural-Urban Migration in China and Indonesia (RUMiCI) Project which is a four-year longitudinal survey starting in 2008. The rural household survey of RUMiCI comprises 8,000 rural households from nine provinces, and uses the same sampling frame as the Rural Household Survey (RHS) conducted by China's National Bureau of Statistics annually. All the household members were interviewed, and if any member was absent at the time of interview, the questions were answered by the household head, spouse or whoever knew the information. Migration information was collected in every wave of the survey, and in the third wave, the retrospective information of the year of the first marriages was also collected.

The definition of migration discussed in this study is labour-related first migration episode. For individuals who ever migrated but returned, the information on when was the last time they came back to their home village continuously for more than three months was also available. If a respondent ever migrated and stayed in the home village when the survey was conducted, he or she is regarded as a return migrant. I constructed a time-variant dummy variable indicating migration status which is equal to one if a respondent migrated at a particular point of time and zero otherwise. This variable can change from zero to one after the first migration and back to zero after returning hometown. Thus, the measurement of migration in this study is not very accurate because some spells of returning hometown may be regarded as ones of migration. For example, If a woman returns to her hometown and stays there for a period between the first migration and the last returning by the timing of survey, she is assumed to stay in urban areas until returning. Even if she marries after returns hometown, she is assumed to marry during the episode of migration. In other words, the negative effect of migration on the marriage age is estimated as a positive effect. Therefore, the effect of migration may be overestimated.

Another time-variant variable in the analysis is a *school enrolment* dummy. Although the information on the age for respondents enrolled in primary school is missing, all the children have to enrol at a certain age, which may vary between six and eight years of age across regions and time in China. In the econometric analysis below, I assume all the respondents enrolled at age six and would not leave school until completing all the schooling they indicated in the survey. Specifically the enrolment dummy changes from zero to one at age six and changed to zero again once the age exceeds the total years of schooling plus six. In the next section, a robustness check is carried out by assuming the universal enrolment age is eight.

One time-invariant control variable is social networks. In the survey, the respondents' household heads were asked to indicate how many friends and relatives they contacted via different means during the Chinese New Year of 2010.[1] Using this information I constructed a quantity variable of the social networks. The rest of the time-invariant controls include minority group status, schooling years, terrains of villages, county fixed effects, and birth cohorts fixed effects.

In addition, the availability of potential mates in the marriage market is a crucial factor in any research related to marriage behaviour. In order to control the availability effect, I used a 1% sample of the 2000 Population Census (National Bureau of Statistics of China, 2001) to calculate the sex ratio variable at the county level. I computed the sex ratio based on 11-year

[1]Admittedly, the measure has error which may be originated from the facts that the heads of household could be fathers or mothers of the observations and that the information collected in 2010 could be different from that in the years of marriages. However, the impact of this error might not be very serious because the social networks do not increase or decrease significantly in comparably isolated areas.

Table 3.1: Summary Statistics

	Male		Female	
Variables	Ever Migrated	Never Migrated	Ever Migrated	Never Migrated
Age	29.35	31.31***	28.24	31.65 ***
	(6.01)	(6.48)	(6.00)	(6.46)
Birth cohort				
Post-1980	0.59	0.43***	0.67	0.41***
	(0.49)	(0.50)	(0.47)	(0.49)
Post-1970	0.41	0.57***	0.33	0.59***
	(0.49)	(0.50)	(0.47)	(0.49)
Birth order	2.00	2.02	1.87	2.06
	(1.16)	(1.22)	(1.08)	(1.21)
Minority status	0.01	0.01	0.01	0.02
	(0.10)	(0.12)	(0.10)	(0.15)
Schooling years	9.07	9.05	8.66	8.34
	(2.15)	(2.42)	(2.20)	(2.57)
Whether married	0.60	0.70***	0.64	0.83***
	(0.49)	(0.46)	(0.48)	(0.38)
Age of the first marriage	23.60[a]	23.62[c]	22.08[d]	22.10[f]
	(2.84)	(2.76)	(2.73)	(2.64)
Age of the first migration	22.37		22.10	
	(4.87)		(5.06)	
Age of return	27.88[b]		27.44[e]	
	(6.17)		(5.96)	
Duration of migration	5.10[b]		4.45[e]	
	(4.37)		(3.98)	
Social networks	34.90	29.26***	36.35	31.96***
	(42.06)	(34.70)	(41.95)	(41.98)

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Variables	Male Ever Migrated	Male Never Migrated	Female Ever Migrated	Female Never Migrated
Terrain				
Plains	0.35	0.49 ***	0.33	0.50***
	(0.48)	(0.50)	(0.47)	(0.50)
Hills	0.46	0.36***	0.49	0.35***
	(0.50)	(0.48)	(0.50)	(0.48)
Mountains	0.19	0.15***	0.18	0.15***
	(0.39)	(0.35)	(0.39)	(0.36)
Sex ratio	1.07	1.02***	1.08	1.02***
	(0.14)	(0.12)	(0.15)	(0.12)
Average schooling years at county level	6.78 (0.42)	7.00 (0.49)	6.74 (0.42)	6.97 (0.47)
Average schooling years of males at county level	7.07 (0.40)	7.27 (0.45)	7.04 (0.40)	7.24 (0.44)
Average schooling years of females at county level	6.46 (0.50)	6.73 (0.57)	6.42 (0.49)	6.69 (0.55)
Number of observations	2,463	1,422	1,636	1,842

Note: standard deviations in parentheses; the numbers of observations for *a, b, c, d, e* and *f* are 1,484, 713, 994, 1,040, 491 and 1,528 respectively; *** indicates significant at 1% level.

age groups for each individual, so that the variable captures not only the geographic variation, but also the variation over time. For example, for a person born in 1980, the sex ratio is defined as the number of males who were born between 1975 and 1985 divided by the number of females in the same county. There is no special reason for the width of age window to be set at 11. Hence, I test the sensitivity of this setting in Section 3.5.

In terms of the quality of competitors in the local marriage market, it is ideal if the average schooling years can be calculated in the same way as *sex ratio*. However, in 2000, many individuals in the sample, particularly from the younger birth cohort, had not finished their education yet. So, I employ the averages of schooling years of males and females, respectively, aged between 16 and 50 at county level in 2000 to control the quality of competitors.

The sample used in this study is restricted to males aged between 18 and 40 and females aged between 16 and 40 in 2010. This age restrictions are compatible with the concept of the labour-related migration. The final sample comprises 3,885 males and 3,478 females, whose marriage and migration histories can be reliably constructed.

The summary statistics of the data in Table 3.1 shows that the proportion of men who migrated in my age restricted sample is 63.40% (=2,463/3,885), and the ratio for women is 47.04% (=1,636/3,478). On average, male migrants are two years younger than male non-migrants, while female migrants are three years younger. Similarly, the younger birth cohort, Post-1980, who were born in the 1980s, accounts for around 60% of the migrants, but only about 40% of non-migrants for both males and females. The results of t-tests suggest that the differences in the all the indicators of age between migrants and non-migrants are significant at 1% level.

Another important outcome of the age structure is that the marriage rate among migrants (about 60% for both males and females) is much lower than for non-migrants. The marriage rate of male non-migrants is 70%, and the figure for female non-migrants is even higher at 83%. On average, the rural males marry one year later than the rural females in China, and migrants and non-migrants have almost the same average age of the first marriage. It seems that rural-urban migration has no effect on the timing of marriage. The conclusion may be very different when taking the unmarried individuals into account. In order to demonstrate this, how the hazard of getting married change with time was shown in Figure 3.1. Whether males or females, and whether migrants or non-migrants, the hazard increased in their early 20s, peaked at about 25, and then kept decreasing. However, the hazard is higher for non-migrants. Further, using the Kaplan-Meier method (Kaplan and Meier, 1958), I estimate the probability of still being unmarried at each particular age (the survival rate curves) for males and females, as shown in Figure 3.2. The curve for male migrants is always above that for male non-migrants, which means that male migrants marry later than male non-migrants (see Figure 3.2a). The difference in the proportions of the unmarried between migrants and non-migrants increases from age 18, peaks at age 26, then starts to decrease, and finally reduces to 4% after age 35. Meanwhile, the survival rate of all the males reduces to about 10%. The pattern for the females is almost the same (see Figure 3.2b). However, because on average females marry for the first time earlier than males, the reduction of the unmarried rate for females is faster than that for males. The difference in survival rate for females between migrants and non-migrants peaks at age 23, three years earlier than males. At around age 36, the survival rate of female non-migrants reduces to zero; while that of female migrants remains at about 5% after age 36. Considering that the marriage ages for migrants and non-migrants are almost identical and that the survival rate curve of migrants is above that of non-migrants, it is the unmarried individuals (the censored observations) who contribute to the difference between migrants and non-migrants in the timing of the first marriage.

In terms of the rural-urban migration behaviour, males and females are quite different. Although the average ages of first migration for males and females are the same, females return half a year earlier than males. As a result, on average, the males' durations of migration are approximately half a year longer than that of the females.

The migrants' social networks, measured by the number of friends and relatives contacted by the householder during the Chinese New Year, are larger than that of non-migrants; however, the difference is not statistically significant. Additionally, migrants, whether male or female, are more likely from hilly or mountainous areas.

Finally, the summary statistics also indicate that compared with non-migrants, male migrants face a more competitive local marriage market because the sex ratio in the local marriage market is higher than that of

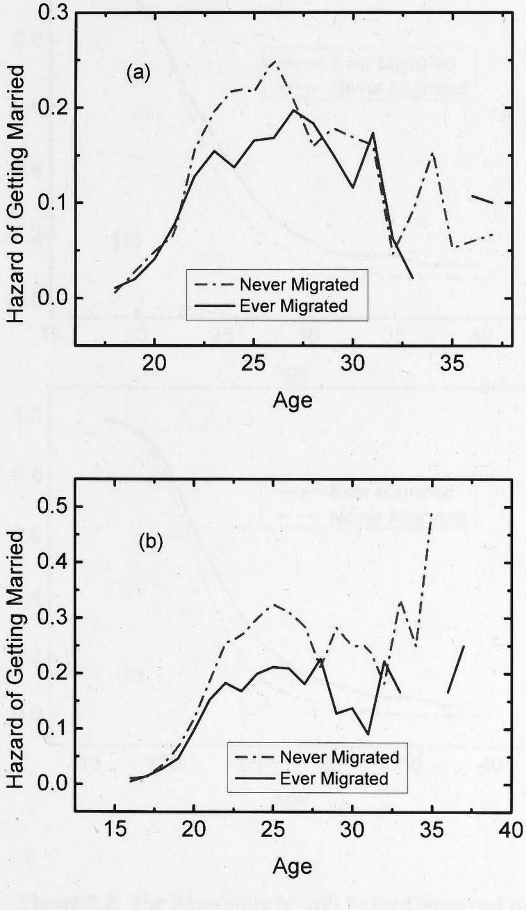

Figure 3.1: The Hazard of Getting Married by Age

(a) Males 18-40 Years; (b) Females 16-40 Years.

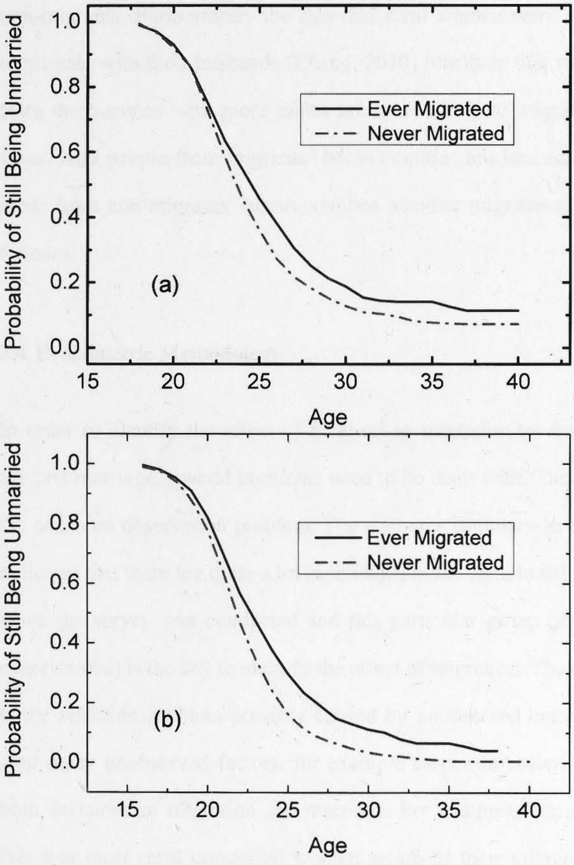

Figure 3.2: The Probability of Still Being Unmarried by Age

(a) Males 18-40 Years; (b) Females 16-40 Years.

non-migrants. Furthermore, the fact that rural women were more likely to migrate with their husbands (Zhang, 2010) results in that rural women from the counties with more males are more likely to migrate to urban areas. And people from migrants' home counties are less educated than those from non-migrants' home counties whether migrants are males or females.

3.4 Econometric Methodology

In order to identify the effect of rural-urban migration on the timing of the first marriage, several problems need to be dealt with. The first one is the censored observation problem. The statistics summary in Section 3.3 indicates that there are quite a lot individuals in the sample still unmarried when the survey was conducted and this particular group (the censored observations) is the key to identify the effect of migration. The second one is the selection problem possibly caused by unobserved heterogeneities. And many unobserved factors, for example career ambitions, can affect both decisions of migration and marriage. For example, considering the fact that most rural unmarried women return to their villages to marry and bear children, and never migrate again (Davin, 1999; Du, 2000; Fan, 2004; Jacka, 1997), the rural women who are ambitious and plan to migrate are more likely to postpone the marriage. If this is the case, the effect of migration on the hazard of the first marriage would be underestimated.

The third one is the reverse causality problem. Rural-urban migration can affect the timing of marriage, whereas it is also reasonable that marriage can impact on rural-urban migration reversely.

In this study, with the help of a bivariate mixed proportional hazard model, these three problems can be solved. The first problem is dealt with by assuming that the hazard function follows the unique form for all the individual including the married and unmarried. When estimating, the probability of still being unmarried at current age for unmarried individuals is introduced into the likelihood function. Second, it is assumed that all selection effects can be captured by the observable and unobserved heterogeneity (van den Berg, 2001). Specifically, in this study, an unobserved heterogeneity which follows two-point distribution, is introduced in the hazard function. In other words, all the participants are classified into two group: those with high susceptibility to marriage (or migration), and those with low susceptibility to marriage (or migration). In this way, the selection effect is mitigated. Third, the reverse causality is taken into concern by introducing a variable indicating marriage status into the hazard function of migration. All the econometric detail will be introduced below. However, as indicated by Abbring and van Den Berg (2003), the assumption of *No anticipation* must be satisfied so that the causality can be identified. This assumption requires that all the respondents cannot anticipate the timing of rural-urban migration or simply do not act on the information. In this study, where migration is a time-variant variable, the identification of the effect of migration on marriage depends on that the hazard of marriage shifts when migration occurs. In other words, people cannot anticipate the occurrence of migration or do not change their plans of marriage according to the migration plans. The assumption of *No anticipation* may be violated in this study because individuals may adjust the hazard of marriage before starting to migrate. In other words, the timing of migration is endogenous, hence the relationship identified in this study is still an association.

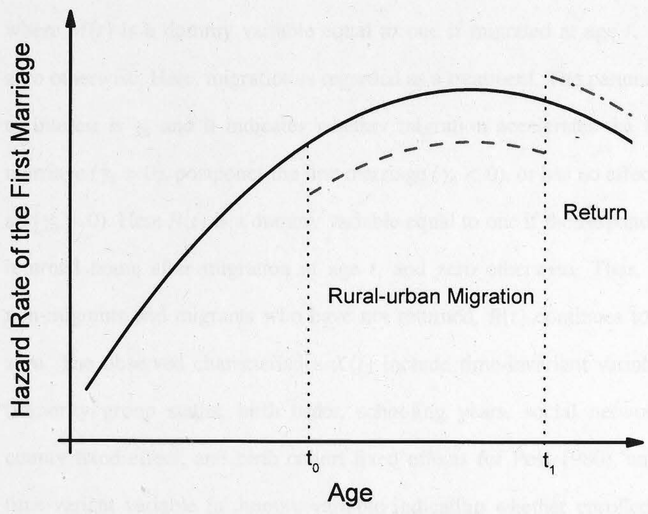

Figure 3.3: The Illustration of the Effect of Rural-Urban Migration on the Hazard of Marriage

An illustration (see Figure 3.3) is helpful to understand the econometric setting. It is assumed that after rural-urban migration t_0, the hazard of the first marriage decreases immediately, and may shift to a new level after returning to hometown, t_1. Mathematically, the annual hazard of the first marriage at age t conditional on observed characteristics $X(t)$, migration status $M(t)$ and $R(t)$, and unobserved heterogeneity v_n is specified as

$$\begin{aligned}\theta_n(t|X(t),M(t),R(t),v_n) =&\lambda_n(t)\exp(X'(t)\beta_n+v_n)\\ &\exp(M(t)\gamma_n)\exp(R(t)\gamma_r)\end{aligned} \tag{3.1}$$

where $M(t)$ is a dummy variable equal to one if migrated at age t, and zero otherwise. Here, migration is regarded as a treatment. The parameter of interest is γ_n and it indicates whether migration accelerates the first marriage ($\gamma_n > 0$), postpones the first marriage ($\gamma_n < 0$), or has no effect at all ($\gamma_n = 0$). Here $R(t)$ is a dummy variable equal to one if the respondent returned home after migration at age t, and zero otherwise. Thus, for non-migrants and migrants who have not returned, $R(t)$ continues to be zero. The observed characteristics $X(t)$ include time-invariant variables (minority group status, birth order, schooling years, social networks, county fixed effect, and birth cohort fixed effects for Post-1980), and a time-variant variable (a dummy variable indicating whether enrolled in school at age t). Here $\lambda_n(t)$ represents the baseline function. In this study, I model the baseline hazard function flexibly as a piece-wise form:

$$\lambda_n(t) = \exp(\Sigma_k \lambda_{nk} I_k(t)) \tag{3.2}$$

where k is a subscript for age-interval and $I_k(t)$ is a time-varying dummy variable which is one in the k^{th} age interval. Further, $\lambda_n(t)$ is also known to be individual duration dependence. Ages 16 and 18 are assumed to be the time in which the potential exposure to marriage begins for females and males respectively.[2] For females, I distinguish 13 age intervals. Of these age intervals, the first one is between 16 and 19 which denotes the period for the illegal marriage, the following 11 intervals are one year in length (age 20, 21, 22,..., 30), and the last one is half open: 31+ years. And for males, I define 11 age intervals with the first one being between 18 and 21 which denotes the period for illegal marriage, and the following nine are one year in length (age 22, 23, 24,..., 30). The last one is half open: 31+ years. Because all λ_{nk}s are estimated, the constant term is normalized to zero. The conditional density function for the completed durations until the first marriage can be written as

$$\begin{aligned} f_n(t|X(t),M(t),R(t),v_n) =& \theta_n(t|X(t),M(t),R(t),v_n) \\ & \exp\left(-\int_0^t \theta_n(h|X(h),M(h),R(h),v_n)dh,\right. \end{aligned} \tag{3.3}$$

In the estimations, I allow the duration until the first marriage to be right censored in order to take into account that some individuals have not married at the time of survey but may do so in the future. This is extremely

[2]As mentioned previously, although according to the Chinese Marriage Law only females aged 20 and above and males aged 22 and above are eligible to marry, there are some individuals in the sample who married earlier than the legal marriage ages.

important because in this study the difference between migrants and non-migrants in the timing of marriage mainly comes from the unmarried individuals. Specifically, for the unmarried individuals, I introduce into the likelihood function the conditional probability of keeping unmarried at age t which can be written as

$$g_n(t|X(t),M(t),R(t),v_n) = \exp(-\int_0^t \theta_n(h|X(h),M(h),R(h),v_n)dh. \tag{3.4}$$

Next, the annual hazard of migration is similarly modelled in the following way

$$\theta_m(t|X(t),N(t),v_m) = \lambda_m(t)\exp(X'(t)\beta_m + v_m)\exp(N(t)\gamma_m), \tag{3.5}$$

where $N(t)$ is a dummy variable equal to one if the individual is married at age t, and zero otherwise. The introduction of $N(t)$ helps to estimate the effect of marriage status on the timing of first rural-urban migration. Therefore, the problem of reverse causality is solved. The observed characteristics $X(t)$ are the same as those in the hazard function of marriage, including minority group status, schooling years, social networks, county dummies, birth cohorts dummies, and a time-variant dummy variable indicating whether enrolled in school at age t. Similarly, the baseline function is defined as $\lambda_m(t) = \exp(\Sigma_l \lambda_{ml} I_l(t))$. Because in this study the rural-urban migrants are defined as those who migrate to a city in order to seek jobs, the start age for the possible migration is different from that of marriage. Considering that in China, the average education level of rural residents is completion of middle school and normally the age for graduation from middle school is 16, I assume that age 16 is the time when the potential exposure to rural-urban migration begins for both males and females. The setting of the piece-wise baseline function is the same between males and females. The first piece is from 16 years to 19 years. The following age intervals are one year in length (age 20, 21,..., 30), and the last one is 31+ years. Because all λ_{ml}s are estimated, the constant is normalized to zero. Then the conditional density function for the first rural-urban migration can be written as

$$\begin{aligned} f_m(t|X(t),N(t),v_m) =& \theta_m(t|X(t),N(t),v_m) \\ & \exp(-\int_0^t \theta_m(h|X(h),N(h),v_m)dh. \end{aligned} \tag{3.6}$$

In the estimation, I allow the duration until the migration for the first time to be right censored in order to take into account that some individuals have not migrated at the time of survey but may do so in the future. Similarly, for the non-migrants, I introduce into the likelihood function the conditional probability of keeping being a non-migrant before age t which can be written as

$$g_m(t|X(t),N(t),v_m) = \exp(-\int_0^t \theta_m(h|X(h),N(h),v_m)dh. \tag{3.7}$$

Finally, the joint distribution of the unobserved heterogeneities, v_n and v_m, is denoted as $G(v_n,v_m)$. The joint density function of the two durations for the unmarried at age t_n and the non-migrant at age t_m can be expressed as

$$f(t_n,t_m|X,M,R,N) = \int_{v_n}\int_{v_m} f_n(t_n|X(t_n),M(t_n),R(t_n),v_n)^N g_n(t_n|X(t_n),M(t_n),R(t_n),v_n)^{1-N}$$
$$f_m(t_m|X(t_m),N(t_m),v_m)^M g_m(t_m|X(t_m),N(t_m),v_m)^{1-M}\, dG(v_n,v_m), \quad (3.8)$$

where N is a binary variable indicating whether the individual is unmarried at the timing of survey (a censored observation); M is a binary variable indicating whether the individual have never migrated before survey (a censored observation); $G(v_n,v_m)$ is assumed to be a discrete distribution with four mass points (v_{n1},v_{m1}), (v_{n2},v_{m1}), (v_{n1},v_{m2}) and (v_{n2},v_{m2}) reflecting the assumption of four types of individuals conditional on observed characteristics and age with respect to the first marriage and the first migration. The first type of males have relatively high susceptibilities to both; the second type of males have a low susceptibility to the marriage but a high susceptibility to the migration; the third type has a high susceptibility to the marriage, but a low susceptibility to the migration; the last type has low susceptibilities to both. The corresponding probabilities are denoted as:

$$\begin{aligned}
\Pr(v_n = v_{n1}, v_n = v_{m1}) &= p_1 \\
\Pr(v_n = v_{n1}, v_n = v_{m2}) &= p_2 \\
\Pr(v_n = v_{n2}, v_n = v_{m1}) &= p_3 \\
\Pr(v_n = v_{n2}, v_n = v_{m2}) &= p_4
\end{aligned} \quad (3.9)$$

where $0 \leq p_j \leq 1$, $j = 1, \ldots, 4$. Because the baseline hazard are also estimated I normalize $v_{n1} = v_{m1} = 0$. Furthermore, p_j $(j = 1, \ldots, 4)$ is assumed to have a multinomial logit specification: $p_j = \exp(\gamma_j) / \sum_j \exp(\gamma_j)$ and the normalization is $\gamma_1 = 0$. This setting can ensure all the probabilities are positive and sum up to one. Please note the unobserved heterogeneities can be estimated and the selection can be explained by all the observable and unobserved heterogeneities. In this way, the selection problem can be dealt with.

3.5 Results and Discussion

3.5.1 Estimation Results for the Basic Model

The estimates of the mixed proportional hazard model of the first marriage for rurl men and women are presented in columns 1 and 4 of Table 3.2. The effect of migration on the timing of the first marriage is insignificant for men, but negative and significant for women. Specifically, the annual hazard rate at which a female rural-urban migrant marries is 29.53% $(1 - \exp(-0.35))$ less than that of a similar female non-migrant. The results indicate that there is a postponing effect of migration on the timing of marriage for females.

In the same table, the estimates of the bivariate hazard model of the hazard of the first marriage and the hazard of rural-urban migration for the first time for males and females are also presented. The most significant changes include that 1) for rural men, the effect of migration on the timing of the first marriage becomes significant and positive. That is, the annual hazard rate at which a male rural-urban migrant marries is 18.53% ($\exp(0.17)-1$) larger than that of a similar male non-migrant. However, 2) the effect of migration on the hazard of the first marriage for a female migrant becomes less, which can only lead to a 24.42% ($1-\exp(-0.28)$) reduction in the hazard. The comparison between the values of the likelihood function, the results of bivariate models should be preferred. Specifically, the value of the likelihood function for the single hazard models is $-15870.61 = -7115.71 - 8754.90$, which is smaller than that of the bivariate model, -15866.31. The numbers for women are $13196.10 = -6860.23 - 6335.87$ and -13119.46 respectively.

It may be concerned that the difference in the estimates of the distribution of heterogeneity with probabilities of marriage and migration and the raw sample proportions are large, which suggests the bivariate hazard models do not fit well. However, the censored sample can also affect the estimate of the heterogeneity.[3] In other words, the unmarried observations, particularly those aged less than 27 may get married in near future. At least

[3] In order to check the impact of censoring sample on the bias in the estimation, I implemented a series of Monte Carlo simulations. The results indicate that if the proportion of censoring sample reaches 30% the bias in the estimate of the mass point of the heterogeneity can be as large as 10%. However, since it is impossible to obtain the proportion of censoring sample in terms of marriage and migration, its impact on the estimation cannot be evaluated.

Table 3.2: The Effect of Rural-Urban Migration in China on the Timing of the First Marriage, Males 18-40 Years & Females 16-40 Years

	Male				Female			
Variables	Marriage	Migration	Marriage	Migration	Marriage	Migration	Marriage	Migration
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Migration	0.08		0.17**		-0.35***		-0.28***	
	(0.06)		(0.07)		(0.07)		(0.07)	
Return migration	-0.21		-0.09		-0.08		0.01	
	(0.17)		(0.18)		(0.20)		(0.20)	
Marriage status		0.01		0.08		-0.12		-0.03
		(0.08)		(0.08)		(0.09)		(0.09)
Minority status	0.66	-1.98***	0.68	-1.98***	-0.14	-0.63	-0.14	-0.6
	(0.42)	(0.68)	(0.42)	(0.69)	(0.32)	(0.63)	(0.33)	(0.61)
Schooling years	-0.04***	0.04***	-0.05***	0.06***	-0.09***	0.08***	-0.09***	0.09***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)	(0.02)
Birth order	-0.05**	0.01	-0.04**	0.01	-0.04**	0.00	-0.05**	-0.01
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)	(0.03)
Enrolment	-1.26***	-0.81***	-1.25***	-1.02***	-1.28***	-1.04***	-1.27***	-1.16***
	(0.33)	(0.12)	(0.33)	(0.12)	(0.30)	(0.16)	(0.30)	(0.16)

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	Male				Female			
Variables	Marriage	Migration	Marriage	Migration	Marriage	Migration	Marriage	Migration
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Social networks	0	0.00	0	0	0	0.00	0	0
	(0.00)	(0.00)	(0.75)	(1.91)	(0.00)	(0.00)	(1.36)	(1.00)
Post-1980[a]	-0.80***	1.55***	-0.82***	1.54***	-0.39***	1.98***	-0.41***	1.95***
	(0.06)	(0.07)	(0.07)	(0.08)	(0.06)	(0.10)	(0.06)	(0.10)
Sex ratio	-0.70**	0.34	-0.73**	0.33	-0.55**	-0.04	-0.51*	0.01
	(0.29)	(0.29)	(0.29)	(0.29)	(0.27)	(0.38)	(0.27)	(0.33)
Average schooling years of males	0.73**		0.86**					
	(0.30)		(0.37)					
Average schooling years of females					-0.21		-0.23	
					(0.30)		(0.25)	
Average schooling years of individuals		-1.81***		-1.79***		-1.75***		-1.83***
		(0.33)		(0.32)		(0.48)		(0.48)
Terrain (Reference Group: Plains)								
Hills	-0.20**	-0.04	-0.20**	-0.01	-0.01	0.15	-0.03	0.16
	(0.10)	(0.12)	(0.10)	(0.09)	(0.10)	(0.14)	(0.12)	(0.13)
Mountains	-0.30**	0.14	-0.29**	0.18	-0.09	0.41	-0.11	0.41**
	(0.14)	(0.14)	(0.14)	(0.14)	(0.13)	(0.17)	(0.13)	(0.17)

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	Male				Female			
Variables	Marriage	Migration	Marriage	Migration	Marriage	Migration	Marriage	Migration
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
County effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Baseline								
≤19 years		7.37***		7.64***	-3.82***	-7.63	0.08	7.45
		(2.39)		(2.39)	(0.06)	(5.69)	(0.07)	(5.69)
20 years		7.89***		8.32***	-2.34***	-7.07	1.56***	8.05
		(2.38)		(2.38)	(0.07)	(5.69)	(0.07)	(5.67)
21 years[b]	-7.53***	8.31***	-7.50***	8.46***	-1.78***	-6.65	2.12***	8.05
	(0.05)	(2.39)	(0.06)	(2.39)	(0.07)	(5.69)	(0.07)	(5.67)
22 years	-6.04***	8.53***	-6.02***	8.57***	-1.40***	-6.59	2.49***	8.2
	(0.06)	(2.39)	(0.07)	(2.39)	(0.08)	(5.69)	(0.08)	(5.69)
23 years	-5.73***	8.78***	-5.70***	8.45***	-1.32***	-6.32	2.57***	8.23
	(0.06)	(2.39)	(0.07)	(2.39)	(0.11)	(5.69)	(0.09)	(5.68)
24 years	-5.65***	8.92***	-5.61***	8.69***	-1.08***	-6.31	2.81***	8.45
	(0.08)	(2.39)	(0.09)	(2.39)	(0.13)	(5.69)	(0.11)	(5.67)
25 years	-5.47***	9.05***	-5.42***	8.80***	-0.89***	-6.14	3.00***	8.3
	(0.09)	(2.38)	(0.10)	(2.38)	(0.16)	(5.69)	(0.14)	(5.68)
26 years	-5.29***	8.94***	-5.23***	8.91***	-0.83***	-6.08	3.04***	8.65
	(0.11)	(2.39)	(0.12)	(2.39)	(0.20)	(5.69)	(0.17)	(5.69)

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	Male				Female			
Variables	Marriage	Migration	Marriage	Migration	Marriage	Migration	Marriage	Migration
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
27 years	-5.14***	9.19***	-5.07***	8.89***	-0.85***	-5.84	3.03***	8.69
	(0.13)	(2.38)	(0.14)	(2.38)	(0.23)	(5.69)	(0.21)	(5.68)
28 years	-5.17***	9.31***	-5.08***	9.15***	-0.83***	-5.98	3.05***	9.05
	(0.16)	(2.38)	(0.16)	(2.38)	(0.28)	(5.69)	(0.25)	(5.69)
29 years	-5.21***	9.41***	-5.13***	9.01***	-0.82**	-5.60	3.05***	8.4
	(0.20)	(2.38)	(0.20)	(2.38)	(0.34)	(5.69)	(0.32)	(5.68)
30 years	-5.32***	9.70***	-5.24***	8.89***	-0.84**	-5.56	3.04***	8.86
	(0.25)	(2.38)	(0.24)	(2.38)	(0.39)	(5.69)	(0.37)	(5.68)
$\geq$31 years	-5.55***	9.55***	-5.57***	9.21***	-0.74**	-5.19	3.13***	8.93
	(0.26)	(2.39)	(0.25)	(2.39)	(0.35)	(5.70)	(0.34)	(5.69)
Heterogeneity								
v_{n2}	-1.96***		-1.85***		-1.49***		-1.46***	
	(0.27)		(0.28)		(0.28)		(0.28)	
v_{m2}		$-\infty$		$-\infty$		$-\infty$		$-\infty$
Distribution of heterogeneity								
γ_2	-2.04***		-0.94***		-2.37***		-0.45***	
	(0.27)		(0.08)		(0.69)		(0.08)	

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	Male				Female			
Variables	Marriage	Migration	Marriage	Migration	Marriage	Migration	Marriage	Migration
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
γ_3		-0.98***	-1.50***			-0.38***	-1.85***	
		(0.05)	(0.38)			(0.05)	(0.56)	
γ_4			-3.48***				-3.75***	
			(0.45)				(1.03)	
p_1	88%	73%	61%		91%	59%	55%	
p_2			23%				35%	
p_3	12%	27%	13%		9%	41%	8%	
p_4			2%				2%	
Log-likelihood	-7115.71	-8754.9	-15,866.31		-6860.23	-6335.87	-13,119.46	
Sample size	3,885				3,478			

Note: standard errors in parentheses; ***, **, and * denote significant at 1%,5% and 10% respectively; *a*, Reference group: Post-1970; *b*, ≤ 21 years for male's marriage hazard.

none of them can contribute to the probability for the negative and infinite heterogeneity. As a result, the estimated probability of being the type who is less susceptible to marriages might be lower than the proportion from the raw data.

Obviously, rural-urban migration is incompatible with marriage for both rural males and females because migrants mare more likely to search for mates from their hometowns (Wang, 2007), as a result of the segregated marriage market due to the *Hukou* system. However, the estimation results show that the effect of migration is positive for males. The difference in the migration effect between females and males may be because of the strength of the patriarchy in China. The patriarchal attitudes are rooted in Confucian traditions, and still prevalent, particularly in the rural China (Hooper, 1984). Adult daughters are expected to leave their homes and join the families of their husbands. According to the traditional culture in China, a daughter-in-law has to be subservient to her husband and her husband's family and her main responsibility is to take care the elderly, children, and the whole family (Wolf, 1972, 1985). Even in contemporary rural China, daughters-in-law are still seen as an important source of labour in their husbands' households (Croll, 1987), but much less likely than men to be engaged in migration.

The patriarchy may result in the difference in the migration effect between males and females in two ways. One is that rural-urban migration may have a signalling effect because migrants are considered as rich and able. Thus, rural males may benefit from the signalling effect because males are thought of as breadwinners for families according to Chinese traditional culture. The abler the male, the greater the number of potential marriage partners available for him in the local marriage market. In contrast, even though female migrants are able and rich, they may not be regarded as good wives or daughters-in-law in the opinion of rural people. Thus, female migrants may have more trouble finding potential marriage partners. Alternatively, the difference in the migration effect on the timing of the first marriage may be simply because after migration, females become more open-minded and change their attitude towards marriage. Again, according to the patriarchal tradition, after a female is married, she should stay at the home of her husband and take care of the whole family, whereas such tradition does not apply to males.

Males from minority ethnic groups marry earlier than non-minorities, while there is no similar significant effect for females. The reason is that in China, individuals from minority groups residing in the ethnic autonomous regions, whether male or female, can marry two years earlier than the legal marriage age according to the Marriage Law (National People's Congress, 1980) and local supplementary regulations (see e.g. Standing Committee of the Tibet Autonomous Region's People's Congress, 1981). In the sample used, there is only one county (out of 81 counties) located in an ethnic autonomous region, and 40 males and 48 females are affected by this particular policy. These respondents comprise the majority of the individuals from a minority group (46 males and 58 females) in this study. Most of these individuals are from the same minority group - Manchu, and according to Manchu tradition, it is ideal if a man marries an older wife (Zhang, 2008). As a result, the estimates show that compared with the non-minority, the males from minority groups marry earlier, while the females marry at almost the same age.

In terms of marriage market conditions, the average education level of potential competitors in the rural marriage market can accelerate the timing of marriage for the males but has no significant effect for females; and the higher the sex ratio, the more competitors in the local marriage market, and the later males marry. The reason is that normally males take the initiative in the marriage markets in China. So, the higher the quality (measured by e.g. education level, income and etc.), the more effort males have to make in searching for mates and the earlier males marry. However, more potential competitors means that some males may fail to find a mate and hence on average the timing of marriage will be postponed.

All the rest of the control variables have similar effects for both males and females on the timing of marriage, or at least the signs of the estimates for the same variables are the same. It is found that schooling years and enrolment in education delay the timing of marriage. The younger the siblings, the later the timing of marriage. The possible reason for this is that in rural China, the eldest child usually has the responsibility to support the whole family and to take care of the elderly. So, the eldest sibling normally settles down into married life earlier, while the younger siblings have the luxury of lengthening the single life. In addition, the difference between the different birth cohorts is very significant. The young birth cohort - those who were born in the 1980s - married much later than those who were born before 1980. This may reflect that the Post-1980 cohort is quite distinct from the older birth cohorts in characteristics, personal value, and life style because they grew up in a relatively stable and material-prosperous society. They serve as a bridge between the Mao's closed China and the new open China and reconcile eastern tradition and western culture (Elegant, 2007).

The trend of the baseline hazard can provide an insight into how the hazard of the first marriage conditional on the observable and the unobserved heterogeneity changes with age. For males, the hazard increases gradually and peaks when they are aged 28, and then starts decreasing. For the females, the hazard always increases with age.

In terms of the distribution of the unobservable heterogeneity, conditional on the observed characteristics there are four groups of individuals who differ in their susceptibilities to the first marriage and the first migration. The estimates in Table 3.2 indicate that, conditional on the observed characteristics, the majority of respondents (about 57% of males and 50% females) in the sample belong to the group with high susceptibilities to both the marriage and the migration; 29% for males are from the group with a high hazard of marriage and a low hazard of migration which is actually zero because the second point of support for migration is negatively infinite, while the for females is much larger (44%); more than 10% of males have a low susceptibility to marriage but a high migration starting rate, while only 5% of females do so; and a few males and females (2% and 1% respectively) have low susceptibility to the first marriage and would never migrate.

Finally, males and females are quite similar in the ways in which various factors affect the timing of migration. The effect of the first marriage on the timing of the first migration is insignificant for both males and females. The reason is that γ_m measures the effect on the timing of first migration, but not migration. As a result, even if all the rural people return their home town after their first marriages (the effect of marriage on migration is very strong and negative), γ_m may still be insignificant because the marriage possibly has nothing to do with the timing of the first migration. People from minority groups have lower hazard rates of migration. More schooling years accelerates migration. Individuals from the areas where people are better educated on average migrated later. People from mountainous areas and the young birth cohort, Post-1980, migrate earlier. Social networks play a positive role in rural-urban migration, whereas the birth order and the sex ratio have no significant effect on the timing of first migration.

3.5.2 Counterfactual Experiments

In order to provide a straightforward understanding of how large the effect of migration is on the timing of the first marriage, I conduct a counterfactual experiment based on the estimation results in Table 3.2. Initially I calculate the probability of still being unmarried (the survival rate) for each age for individuals with a high susceptibility and those with a low susceptibility. Then, according to the proportion of each type of individual, the probability of still being unmarried for the whole population can also be calculated. Furthermore, I assume that the migrant initially moves to the cities at age 22 for the first time and returns to home at age 28, which is the same as the mean of uncensored sample. All the other characteristics are also set to equal the mean of the sample. The results are shown in Figure 3.4.

There are two types of individuals: those with a high susceptibility to marriage (v_{n1}) who have a high probability to marry and marry early, and those with a low susceptibility to marriage (v_{n2}) who marry late. From Figure 3.4(a), it can be seen that the survival rate of the males with a high susceptibility (v_{n1}) to marriage decreases much faster than that of the males with a low susceptibility (v_{n2}). At age 40, the probability of still being unmarried for the males with (v_{n2}) is nearly 50%; meanwhile almost all the males with (v_{n1}) are already married. It can also be seen that the effect of migration on the timing of marriage for the males with a high

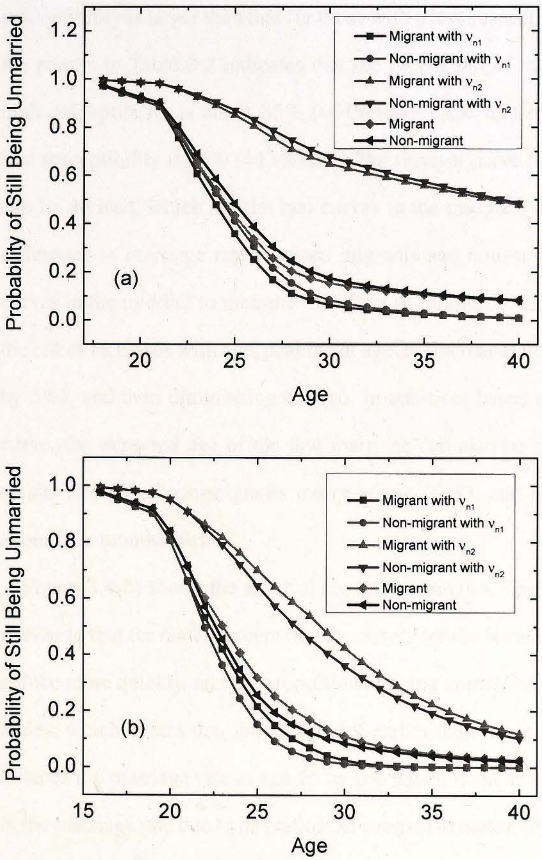

Figure 3.4: The Effect of Rural-Urban Migration in China on the Timing of Marriage for Individuals with Different Heterogeneity

(a) Males 18-40 Years; (b) Females 16-40 Years.

susceptibility is larger than that for those with a low susceptibility. Because the results in Table 3.2 indicates that the proportion of the males with a high susceptibility is about 85% (=61%+24%) and that of males with a low susceptibility is 15% (=13%+2%), the survival curve for all the males can be derived, which are the two curves in the middle. And if using the difference in marriage rate between migrants and non-migrants (the two curves in the middle) to measure the effect of migration, the magnitude of the effect increases with age, peaking at age 26 (increases the marriage rate by 5%), and then diminishing to zero. In addition, based on the survival curve, the expected age of the first marriage can also be calculated. The results show that non-migrants marry at age 23.33, and migrants marry about four months earlier.

Figure 3.4(b) shows the survival curves for females. The pattern is very similar to that for males, except that the curves for the female sample group reduce more quickly, and the proportion of being unmarried is smaller than males, which means that females marry earlier than for males. Migration reduces the marriage rate at age 26 by 6% which is the maximum change in the marriage rate due to migration. In contrast to males, the expected age of the first marriage of female migrants is four months later than female non-migrant.

Although on average rural-urban migration only postpones or accelerates the age of the first marriage by about four months, it cannot be concluded that the effect of migration on the timing of the first marriage

Table 3.3: The Effect of Rural-Urban Migration in China on the Marriage Rate, Males 18-40 Years & Females 16-40 Years

Age	Male	Female
22	1.68%	-3.10%
23	3.28%	-5.02%
24	4.34%	-6.09%
25	4.94%	-6.27%
26	5.05%	-5.84%
27	4.73%	-5.21%
28	4.21%	-4.56%
29	2.92%	-3.23%
30	2.12%	-2.38%
31	1.68%	-1.78%
32	1.33%	-1.38%
33	1.06%	-1.10%
34	0.84%	-0.91%
35	0.66%	-0.76%
36	0.52%	-0.64%
37	0.41%	-0.55%
38	0.32%	-0.47%
39	0.25%	-0.41%
40	0.19%	-0.36%

is small. First, from the results in Table 3.2, the effect of migration on the timing of the first marriage is very large: migration changes the hazard by 18.53% for males and 24.09% for females. Second, the effect of rural-urban migration on the marriage rate is not small. Table 3.3 shows how the change in the marriage rate due to migration varies age based on the results of counterfactual experiments shown in Figure 3.4. Taking females as an example, the marriage rate between age 23 and 28 is reduced by about 5%

if they stay in cities between age 22 and 28. Combining the facts that more than 50% rural women give birth during this age span (see Figure 2.3) and that Chinese women commonly give birth after being married, the effect of deferred marriage due to migration is large.

The main reason to the *small* effect of migration on the expected age of the first marriage is that the hazard of the first marriage is very large. Even after being decreased by 25%, the hazard is still large. One consequence is that individuals marry when they are very young. This point can be confirmed by Figure 3.2 which shows that about 30% males and 50% females have already married before age 22. In other words, many individuals would have been married before migration if their migration plans are the same as assumed in the counterfactual experiments. Another consequence is that the distribution of the marriage age is very narrow. Its standard deviation is only 2 years as shown in Table 3.1. So, although the age of marriage is changed by only four months, the change in the marriage rate at some ages may be very large.

3.5.3 Robustness Checks

To investigate the sensitivity of the results, I perform a series of robustness checks. The first one tests whether migration could have already affected on the timing of marriage even before the realization of migration. This test is related to the assumption of No Anticipation. If rural-urban migrants can anticipate the occurrence of migration perfectly, the decisions on migration and marriage could be made at the same time. As a result, the timing of migration is endogenous and its estimate would be inconsistent. This concern is related to the fact that the elderly in rural China after age 60 primarily depend on family support (Cai et al., 2012). It is likely that men, whose responsibility is to satisfy the demands of their parents according to the traditional culture in China, may marry before migration and leave wives to take care of parents. In this case, before rural-urban migration realizes, the hazard of marriage has increased already (as illustrated in Figure 3.5). To model this phenomenon, the hazard function for marriage is augmented as follows:

$$\theta_n(t|X(t),M(t),R(t),v_n) = \lambda_n(t)\exp(X'(t)\beta_n + v_n)\exp(M(t)\gamma_n)$$
$$\exp(R(t)\gamma_r)\exp(P(t)\gamma_p) \tag{3.10}$$

where $P(t)$ follows a piece-wise form, $P(t) = \sum_s P_s I_s(t)$, and s is a subscript for age-interval and I_s is a time-varying dummy variable which is one in the s^{th} age interval and zero in the others. I distinguish five one-year age intervals before the migration, i.e. $s \in \{1,2,\ldots,5\}$. The results in Table 3.4 show that the effects of the several years before migration on the timing of marriage are all insignificant and the estimations of the migration effect remain the same for both males and females. Thus, the estimated results are quite robust to the possible effect of pre-migration. They also suggest that the assumption of No anticipation could be satisfied in this study, although this assumption cannot be tested empirically.

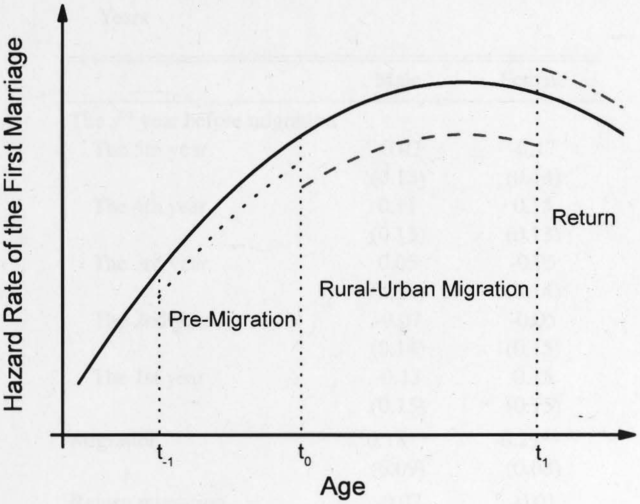

Figure 3.5: The Illustration of the Effect of Pre Rural-Urban Migration on the Hazard of Marriage

One concern is that controlling education attainment with schooling years could be not proper because the effect of education is assumed to be linear. Thus, I introduce two binary variables indicating whether or not the individual completed higher than primary education but less than senior high schools, or equivalence (between seven and nine years); and whether or not had higher than junior high education or equivalence (more than

Table 3.4: The Effect of Pre Rural-Urban Migration on the Timing of the First Marriage in China, Males 18-40 Years & Females 16-40 Years

	Male	Female
The s^{th} year before migration		
The 5th year	-0.03	-0.17
	(0.13)	(0.14)
The 4th year	0.11	0.15
	(0.13)	(0.13)
The 3rd year	0.05	-0.05
	(0.14)	(0.14)
The 2nd year	-0.07	-0.05
	(0.14)	(0.15)
The 1st year	-0.13	0.15
	(0.15)	(0.15)
Migration	0.18**	-0.29***
	(0.09)	(0.08)
Return migration	-0.07	-0.01
	(0.18)	(0.20)
Log likelihood	-15,860.73	-13,151.68
Number of observations	3,885	3,478

Note: standard errors in parentheses; ***, **, and * denote significant at 1%, 5% and 10% respectively; full results are shown in Table A.5.

nine years). The results shown in column (2) of Table 3.5 indicate that the estimates of the basic model are not sensitive to the linear assumption on education attainment compared with the results of basic model shown in column (1).

The third test is related to the local marriage market. In the basic model, I compute the sex ratio based on 11-year age groups for each respondent to control for the availability of potential mates. To test the sensitivity of this setting of 11-year age intervals, I change the length of the age window to nine years or 13 years, and the estimated results are shown in columns (3) and (4) of Table 3.5 respectively. Furthermore, in order to take into account the fact that men usually marry younger women, I restructure the variable, sex ratio, by matching men with women one year, two years and until five years younger. Since the results for different setting are quite similar, I only report the results of one-year and five-year in columns (5) and (6) of Table 3.5 respectively. Overall, the estimation of the migration effect is very robust.

3.5.4 Heterogeneity of the Migration Effect

In the previous models, the effect of rural-urban migration γ_n is constant, which does not depend on the time elapsed since the first migration ($t - t_{fm}$ where t_{fm} is the time of the first migration) or the observed characteristics Z . So the systematic heterogeneity of this treatment across individuals from migration duration and personal characteristics is ignored. However, it is reasonable to consider that the effect of the treatment (rural-urban migration) on the timing of marriage may be reinforced or fade out and it also may vary across different individuals. Thus, I consider a model with duration dependence and observed heterogeneity in the treatment effect. Specifically, I replace γ_n by $\gamma_n(t - t_{fm}, Z) = \delta(t - t_{mf}) + Z'\sigma$. In this way,

Table 3.5: The Robustness Checks, 3,885 Males 18-40 Years & 3,478 Females 16-40 Years

	(1) Basic model	(2)	(3)	(4)	(5)	(6)
Males						
Migration	0.17**	0.16**	0.17**	0.18**	0.17**	0.17**
	(0.07)	(0.08)	(0.07)	(0.07)	(0.07)	(0.07)
Return	-0.09	-0.08	-0.09	-0.08	-0.08	-0.08
	(0.18)	(0.19)	(0.18)	(0.17)	(0.18)	(0.18)
Log likelihood	-15,866	-15,839	-15,869	-15,859	-15,868	-15,867
Females						
Migration	-0.28 ***	-0.27***	-0.28***	-0.26***	-0.28***	-0.27***
	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)
Return	0.01	-0.00	0.00	0.02	0.01	0.00
	(0.20)	(0.00)	(0.00)	(0.18)	(0.19)	(0.17)
Log likelihood	-13,119	-13,110	-13,120	-13,131	-13,120	-13,120

Note: standard errors in parentheses; ***, **, and * denote significant at 1%, 5% and 10% respectively.

the effect of migration is not a constant but depends on the time elapsed since the age of the first migration, $t-t_{fm}$, and the personal characteristics Z. Here, I take δ to be a piecewise constant function of $t-t_{fm}$ which is similar to the duration dependence parameterizations of the hazard rates introduced in Section 3.4. So,

$$\gamma_n(t-t_{fm},Z)=\Sigma_g\lambda_{\delta g}I_g(t-t_{mf})+Z'\sigma \tag{3.11}$$

where $I_g(t - t_{mf})$ are time-variant dummy variables. I distinguish four intervals and assume that γ_n is constant within each intervals. The first interval is the first year since the migration; the second and third ones are the two two-year intervals immediately after the first interval, and the last piece is half open (after the fifth year). Obviously, the extended model is more informative on the effect of migration on the timing of the first marriage.

Firstly, I only allow γ_n to depend on the time that has elapsed since the migration. The estimates of the coefficients β_n and β_m, the baseline hazards, and the heterogeneities along with its distribution are very similar to those in Table 3.2. So, in Table 3.6, I only report the heterogeneous treatment effect in the columns (1) and (4). The results in column (1) show that for rural males, the effect of migration is always positive but only significant for the first year or after five years. For the rural females, the effect is always negative, and becomes significant and remains at a high level after two years (see column 4). These findings may indicate that when rural males stay in cities long enough, their ability can be recognized by the potential partners in their home villages and then the timing of the first marriage is accelerated; while, after the two-year migration, the timing of marriage of rural females is affected.

Next, I allow γ_n also to depend on personal characteristics. In order to ensure that the regression is manageable, I only include a dummy variable indicating whether the respondent comes from the young birth cohort,

Table 3.6: The Heterogeneous Effect of Rural-Urban Migration in China, Males 18-40 Years & Females 16-40 Years

	Males			Females		
	(1)	(2)	(3)	(4)	(5)	(6)
Time since migration						
the 1st year	0.22**	0.22*	0.05	0.02	0.26*	0.18
	(0.11)	(0.12)	(0.20)	(0.13)	(0.15)	(0.19)
the 2nd year	0.15	0.16	-0.02	-0.11	0.15	0.07
	(0.11)	(0.12)	(0.20)	(0.12)	(0.15)	(0.19)
the 3rd year	0.17	0.17	-0.01	-0.38***	-0.11	-0.19
	(0.11)	(0.12)	(0.20)	(0.13)	(0.16)	(0.20)
the 4th and 5th years	0.10	0.10	-0.08	-0.48***	-0.20	-0.29
	(0.10)	(0.11)	(0.20)	(0.11)	(0.14)	(0.19)
later than the 5th year	0.34***	0.34***	0.16	-0.41***	-0.13	-0.24
	(0.11)	(0.13)	(0.21)	(0.13)	(0.16)	(0.20)
Individual characteristics						
Post-1980		0.00	0.00		-0.38***	-0.37***
		(0.00)	(0.11)		(0.13)	(0.13)

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	Males			Females		
	(1)	(2)	(3)	(4)	(5)	(6)
Education level						
Middle schools			0.21			0.15
			(0.17)			(0.15)
High schools			0.12			-0.16
			(0.19)			(0.20)
Return migration	-0.05	-0.05	-0.05	-0.01	-0.04	-0.05
	(0.18)	(0.17)	(0.19)	(0.14)	(0.18)	(0.20)
Log likelihood	-15,863.38	-15,863.38	-15862.30	-13,111.99	-13,107.94	-13072.70
Number of observations	3,885	3,885	3,885	3,478	3,478	3,478

Note: standard errors in parentheses; ***, **, and * denote significant at 1%, 5%, and 10% respectively; full results for males are shown in Table A.8; full results for females are shown in Table A.9.

Post-1980. The columns (2) and (5) of Table 3.6 present the estimates of $\lambda_{\delta g}$ and σ. Again, I do not report the other parameter estimates for this model because they are very similar to those in Table 3.2. I find that allowing γ_n to depend on a dummy of Post-1980 does not change the estimates of $\lambda_{\delta g}$, for males. However, for females, all the estimates become insignificant. Thus, the heterogeneity in the effect of migration due to the birth cohorts is important for females but not for males.

Further, it can be argued that education, but not the effect of birth cohorts, is the essential reason to the heterogeneity in the effect of migration because commonly younger birth cohorts are better educated. Thus, I introduce two binary variables indicating whether or not the individual completed higher than primary education but less than senior high schools, or equivalence (between seven and nine years); and whether or not had higher than junior high education or equivalence (more than nine years). The reference group is those with complete or incomplete primary education. The results in columns (3) and (6) of Table 3.6 show that for males, all estimates become insignificant, however, the signs of the estimates remain the same. For females, the estimate of Post-1980 is still significant. Please note comparing the columns (5) and (6), the likelihood ratio test, $70.48 = -2 \times (-13,107.94 + 13,072.70)$, suggests that the first year since migration and the variable for education level could be correlated with the very beginning of migration. The reason could be that majority of rural people, particularly women, migrated immediately after finishing all the schooling if they choose to migrate. However, from the estimates, it cannot be confirmed whether education level or the first year migration changes the effect of migration significantly. Overall, males delay the first marriage if they stay in cities longer; while for females, the effect of the birth cohort is the root reason for delaying the first marriage due to migration.

3.6 Conclusion

This study investigates the effect of rural-urban migration on the timing of the first marriage in rural China. With the help of a bivariate mixed proportional hazards model, the censored observations problem, the selection problem and the reverse causality problem are mitigated to some extent. However, because the *No Anticipation* assumption is violated, the effect identified in this study is still the association between the timing of rural-urban migration and the timing of the first marriage. The results show that the hazard rate of male rural-urban migrants to marry is 18.53% larger than that of similar male non-migrants, while the hazard rate of marriage for female migrants is 24.09% lower than that of similar female non-migrants. Although the effect of rural-urban migration is quite large, for males, migrants marry earlier than the similar non-migrants by only four months; while for females, migrants marry later by four months than their non-migrant counterpart. The root reason for this seemly contradiction is that the hazard of firs marriage is extremely high. For example, for a rural woman, the hazard of the first marriage is still quite large even when it is decreased by about 25% after migration. So, individuals have married before rural-urban migration takes effect.

Furthermore, considering the findings of Ding and Meng (2011) that rural-urban migration postpones the timing of the first birth by about seven months for rural females in China, the delay in the first marriage due to migration accounts for more than half of the postponement in the first birth.

In addition, the difference between males and females in the effect of rural-urban migration may be because of the patriarchy culture which is still prevalent in rural China. More detailed analysis on the heterogeneity in the effect of rural-urban migration shows that after migration within one year and after five years, the hazard rate of marriage for males increases significantly. In contrast, for females, the large postponement effect of migration on the first marriage is mainly due to the birth cohort effect, but not to the time elapsed since the first migration.

Finally, it should be pointed out that the difference in the timing of the first marriage between migrants and non-migrants mainly comes from the unmarried individuals in the sample used. And the majority of the unmarried respondents are from the young birth cohort, Post-1980. Thus, it is very possible that Post-1980 migrants are very distinct from the mature birth cohorts. As a result, the hazard function of Post-1980 may be different from those of the mature generations. However, when dealing with the censored observation problem in the duration analysis framework, it is assumed that the hazard function is universal across the whole population. Although I try to capture the difference by introducing a dummy variable of Post-1980, the estimation specification may be still incorrect. However, the availability of information limits further research on this issue.

Chapter 4

The Effect of Rural-Urban Migration on Cigarette Smoking: Evidence from China

Abstract It is well established that tobacco use leads to preventable morbidity and mortality. In order to propose effective tobacco-control policies, most studies investigate the difference in smoking behaviour across population subgroups. In this study, I examine the effect of rural-urban migration in China on migrants' smoking behaviour. The OLS estimates show that the correlation between the rural-urban migration status and the current smoking status is very weak. However, when mitigating for omitted variable bias and reverse causality problem, the estimates of fixed-effect models show that the rural-urban migration has a significant and positive effect on the current smoking status. Furthermore, duration analysis indicates that migration is correlated with an increase of about five to eight percent in the hazard of the smoking onset. More alarmingly, the correlation is even more substantial for the younger birth cohort.

Key words: Rural-urban Migrant; Cigarette Smoking; China

4.1 Introduction

Health researchers have found that the earlier an individual starts smoking, the longer duration of smoking, the heavier daily consumption, the higher illness risk related to smoking, and the higher chance of nicotine dependence, and thus the greater difficulties in quitting (Breslau and Peterson, 1996; Hegmann et al., 1993; Khuder et al., 1999; Taioli and Wynder, 1991). The World Health Organization (2008) estimates that cigarette smoking kills 5.4 million people globally each year, and the annual death toll will double by 2030. Much of this morbidity and mortality due to tobacco use is preventable (Porter et al., 2003).

Governments have sought to prevent the uptake of smoking and to reduce the smoke-related health risks for smokers and for others through second-hand smoke by passing laws forbidding smoking in public places and launching public campaigns to raise social awareness. Yet, the situation of tobacco control is still very grim. In some countries, especially developing countries, the smoking population remains large and is increasing. China, for example, has the largest smoking population in the world, 301 million in 2010 (GATS, 2010), and the largest non-smoking population exposed to secondhand smoke (Li and Xiao, 2010). As a result, China also has a large death toll due to smoking - 1.19 million in 2005 and predicted to be more than 3 million among the population aged more than 40 in 2020 (Yang and Yu, 2010).

Smoking behaviour has been a focus of interest in health economics (Morrisey and Cawley, 2008), especially, the difference in smoking behaviour across population subgroups such as by gender, race, education, socioeconomic status (SES), migration status etc. (see e.g. Acevedo-Garcia et al., 2005; Adler et al., 1994; Baluja et al., 2003; Cutler and Lleras-Muney, 2010). In terms of migration, many factors can affect smoking status and initiation, for example the culture background, loneliness caused by the shrinking social networks after migration, poor self-esteem resulted by discrimination from local residents and an increase in job pressure can induce smoking, and the fact that migrants are not randomly selected from the source population (Ayyagari and Sindelar, 2010; Croghan et al., 2006; Glendinning and Inglis, 1999). However, the studies on international immigration are not conclusive because the effects of these factors are mixed. For example, Wilkinson et al. (2005) and Tong et al. (2012) showed that the smoking rate among Mexican immigrants in US is lower than US-born people and Mexicans who never migrated, while Jorgensen et al. (2005) found the immigrants from Finland to Sweden were more likely to smoke by investigating the smoking rates of Finnish twins at least one of whom migrated to Sweden. Stoddard (2009) pointed out that the lower smoking rate among Mexico migrants cannot be explained by culture characteristics and argued that they are receptive to smoking prevention efforts after immigration. However, Jorgensen et al. (2005) questioned this argument because the high smoking rate among Finnish migrants, they found, was already present before migration.

Unlike international immigration in US or Europe, substantial health or epidemiological studies consistently demonstrated that rural-urban migration in China is positively associated with high smoking rates. For example, Yang et al. (2009) showed that solitude is the main trigger of smoking for rural-urban migrants in China. Chen et al. (2004) and Finch et al. (2010) pointed out that female migrant in Beijing had disproportionally high rate of smoking. Cui et al. (2012) showed that the high prevalence of both life stress and work stress is associated with current smoking. However, all the studies suffered from the endogenous problem because firstly many unobserved factors, for instance health status, may correlate with smoking and migration simultaneously. The other typical example is risk preference. Risk-takers are more likely to migrate in order to see the outside world; meanwhile, in order to seek thrills they have a higher probability to smoke. The second possible cause of endogenous problem is that rural-urban migrants are not randomly selected from the rural population (i.e. the selection problem). Thus, further researches on the causal effect of rural-urban migration are warranted.

This study examines the extent to which rural-urban migration increases the likelihood of smoking and accelerates smoking initiation by using the rural sample of the data from Rural-Urban Migration in China and Indonesia (RUMiCI) project. Specifically, in this study, the current migrants are those with rural Hukous who lived in cities when RUMiCI was carried out, while those who resided in rural areas are the current non-migrants. And according to participants' answers to the question - *Are you currently a regular smoker?*, participants were divided into two groups: current smokers and current non-smokers. In terms of the current smoking status, the results of OLS show that rural-urban migration has no impact at all. In order to solve the endogeneity problem, fixed-effect models, which can deal with the time-constant unobserved heterogeneity, are employed. The results after controlling for the fixed-effects at the individual level show that rural-urban migration increases the probability of smoking by three to four percent.

In order to analyse the effect of rural-urban migration on the timing of smoking onset, a proportional hazard model is employed. The results suggest that rural-urban migration can increase the hazard of smoking by about 5% to 8%. More alarmingly I find that the migration effects on the timing of smoking onset are much larger for younger birth cohorts. However, the results may be underestimated because of ignoring the unobserved heterogeneity. In the next chapter, the issue will be investigated.

The chapter is structured as follows. The next section presents background on tobacco consumption and rural-urban migration in China. Section 3 presents the data and methodology used in the study. Section 4 discusses the empirical results, before the conclusions.

4.2 Background

4.2.1 Rural-Urban Migration in China

The circumstances of smoking onset risk are built into widespread economic and social contexts with limited regularity controls. An understanding of the extent of the risks is vital for the development of possible responses.

Starting in 1978, China implemented a series of radical policies, known as economic reform, which have had significant effects on both of the economy and people's behaviour in China (see e.g. Bettelheim, 1988; Lin et al., 1996). Originally, Chinese economic reform provided peasants with the opportunity to trade their produce and to allocate their labour. In this way, many rural residents turned to various other activities, such as service work in urban areas (Woon, 1993). However, before the mid 1990s, the government kept a tight control over rural-urban migration in response to this unexpected movement. Without approval for migration from regional governments of both sending and receiving areas, rural-urban migrants would be sent back to their hometown for *security* reasons. In addition, migrants were not eligible for the jobs posted by the urban governments. Even though there were many restrictions, during the 1990s, as the income gap between urban and rural areas increased, better job opportunities in cities became the main reason for rural population migration (Du et al., 2005). World Bank (2009) shows that the population migrating from rural areas to urban areas grew from 38.9 million in 1997 to 61.3 million in 2000. From 2000, the government started to implement policies to improve migrants' welfare. Although the effects of these policies were limited (Meng et al., 2010), the number of migrants continued to escalate to 145.3 million in 2009 estimated by National Bureau of Statistics of China (2010).

Built into the regulation of rural-urban migrants is the discrimination against migrants moving to urban areas and this affects their overall stress. Compared with urban residents, migrants cannot get equal access to schooling, housing, health insurance, work insurance, and retirement benefits. Additionally, there is significant occupational segregation between urban workers and migrants in host cities (Meng, 2005; Meng and Zhang, 2001). Migrants mainly take part in heavy manual jobs, such as construction work, manufacturing work, and in the service industry. Correspondingly, migrants' income is much lower than that of urban residents. Furthermore urbanites are so hostile to migrants that they are not willing to share them with their own the higher living standards (Zhao, 1999). This hostility possessed by urban residents has hurt rural-urban migrants' confidence and self-respect (Guo, 2004). Finally, the public media often unfairly deem migrants as a factor to the increase in crime rates in urban areas, and competitor for jobs of urban residents (Davin, 2000).

4.2.2 Tobacco Consumption and Its Control in China

The risk of smoking onset is also socially structured in China. China has the largest smoking population, the largest non-smoking population exposed to secondhand smoke, and the largest death toll due to smoking (GATS, 2010). This is the case not only because of the immense population in China, but also because of the high prevalence rate of smoking. Although for females aged 15-69 in China the prevalence for current smoking is only 2 to 3 percent because in China female smoking carries a stigma, the prevalence for males aged 15-69 is about 50 percent, which is among the highest in the world (Li and Xiao, 2010). As a result, the prevalence for the whole population is near to 30 percent - still a very high figure. Considering the large smoking population and high prevalence rate, it is not surprising the tobacco market in China is also the largest in the world. In 2010, the consumption of tobacco was 2,375.27 billion cigarettes NBS (2011). On average, each current smoker consumed more than 18 cigarettes per day.

The structure of this large market is a monopoly. China National Tobacco Corporation, the only tobacco firm in China, is a state-owned company which has altogether 34 subsidiaries in charge of marketing and selling in each province and 16 subsidiaries in charge of production CNTC (2011). The corporation is a typical example of one identical institution under two different names. Its other name is State Tobacco Monopoly

Administration, indicating that it is also a branch of government. All cigarette products are sold uniformly. It is possible that the price of cigarettes of the same brand and model varies slightly across different areas. However, migrants have much more brands and models to choose in urban areas than in rural areas. Thus, even if migrants cannot buy the identical cigarettes at the same price as in their hometown, it is straightforward for them to find substitutes at the same price. Lance, Akin et al. (2004) also show that the price elasticity of cigarette demand in China ranged from 0 to -0.15, which is much larger than United States estimates of about 0.4. Thus, in this study, the price effect might be of little concern.

The grim situation in tobacco control of China is mainly because of government's indifference. It is helpful at this point to review the timeline of how China became a Party of the Framework Convention on Tobacco Control (FCTC). After 2 years' negotiation, at the end of 2003, China signed the FCTC, next the Standing Committee of the 10th National People's Congress (NPC) ratified the FCTC in 2005, and a half year later the FCTC took effect (Shan and Xin, 2011). However, it was not until 2011 that a ban on smoking in most public places in China went into effect (Chen, 2011). Meanwhile, from 2000 to 2010, total cigarette production increased by nearly 40 percent (calculated by author based on the data from NBS 2011). This is clear evidence that the intervention by government is weak. The other sign of indifference is that detailed regulation is insufficient. For example, tobacco companies are forbidden to advertise on public media, such as TV, radio, or newspapers (NPCSC, 1994). However, there is no specific rule forbidding indirect advertisements. As a result, a Hope Elementary School[1] in Sichuan province is named as Sichuan Tobacco Hope Elementary School because the school was donated by China National Tobacco Corporation's subsidiaries in Sichuan province. The school motto is "Genius comes from hard work; Tobacco helps you to be successful!" Sichuan Tobacco Hope Elementary School is not the only example in China -there are more than 100 Hope schools named after China National Tobacco Corporation and its subsidiaries (Yang, Yang et al. 2010). Overall, it will be a long and arduous process for successful tobacco control in China. Fortunately, Rural-Urban Migration in China and Indonesia (RUMiCI) data provides a unique insight into this challenge.

4.3 Data and Methodology

4.3.1 Data

The data used in this study is from the first and second waves of Rural-Urban Migration in China and Indonesia (RUMiCI), because in these two waves, the information on the age of starting smoking and the age of quitting was collected respectively. In the Chinese part of RUMiCI, 8,000

[1]In order to bring schools into poverty-stricken rural areas of China, Hope project raises fund and builds *Hope Elementary Schools*. To aid one school, the donor needs to donated 0.4 million Renminbi Yuan and then have the right to name it.

rural households were randomly sampled within the annual income and expenditure survey framework of China's National Bureau of Statistics (NBS). The information on individual and household characteristics, current smoking status, as well as people's smoking and migration history, was collected.

Table 4.1: Data Summary

	Current Migrants		Current Non-migrants	
	Mean	(S.d.)	Mean	(S.d.)
Whether ever smoked	0.38	(0.49)	0.49	(0.50)***
Age	29.72	(7.93)	37.06	(9.02)***
Schooling years	8.85	(2.18)	8.48	(2.25)***
Whether married	0.62	(0.49)	0.83	(0.38)***
Minority status	0.01	(0.10)	0.01	(0.10)
Household income per capita (10^4 Yuan)	4.56	(2.85)	5.65	(4.59)***
Social networks	48.24	(84.36)	41.98	(66.63)***
Sample size	4,990		9,427	

Note: *** denotes the difference significant at 1% according to t-tests.

The sample used in this study is restricted to males because the current smoking prevalence rate of rural women aged more than 15 in China is less than 3 percent, while that of corresponding rural men is more than 50 percent (GATS, 2010; Li et al., 2011). The age range was restricted from 18 and 50 years because the main cause for migration is to seek jobs in cities and so the migration rate among the younger group (aged between 15 and 18) is very low. This provided an unbalanced 2-wave panel of 7,601 males aged between 18 and 50 years in 2008 and 14,417 observations. Among these observations, there are 4,990 migrants and 9,427 non-migrants. Within the sample, 6,787 males whose smoking history can be reliably constructed are used for the duration analysis.

Summary statistics of the data are shown in Table 4.1. The smoking prevalence rate in the sample used is much lower than that in GATS (2010). It could be because the rural men aged more than 50, excluded from this study, are a group with a relatively high smoking rate as indicated by GATS (2010). The summary shows that migrants' smoking rate is significantly lower. The possible reason is that rural-urban migrants are from younger birth cohorts; in contrast, the older the birth cohort, the larger the prevalence rate of smoking. It can be seen from Figure 4.1(a) that migrants have higher hazard of smoking in their whole lives. Whether migrants or non-migrants, the hazard peaks at age 20, 25 and 30 because of the retrospective nature of the data. Please note the extreme large value of the hazard rate after age 40 is due to the small sample size. Figure 4.1(b) further shows that for the young birth cohorts, migrants' smoking prevalence rate is significantly higher than that of non-migrants'. For the middle cohorts, there is not much difference between migrants and non-migrants. For the mature cohorts, migrants are less likely to smoke perhaps because of self-selection. After all, healthier people are more likely to migrate, especially in the older cohorts as the long term health effect of smoking is significant among the elderly. The age distribution for

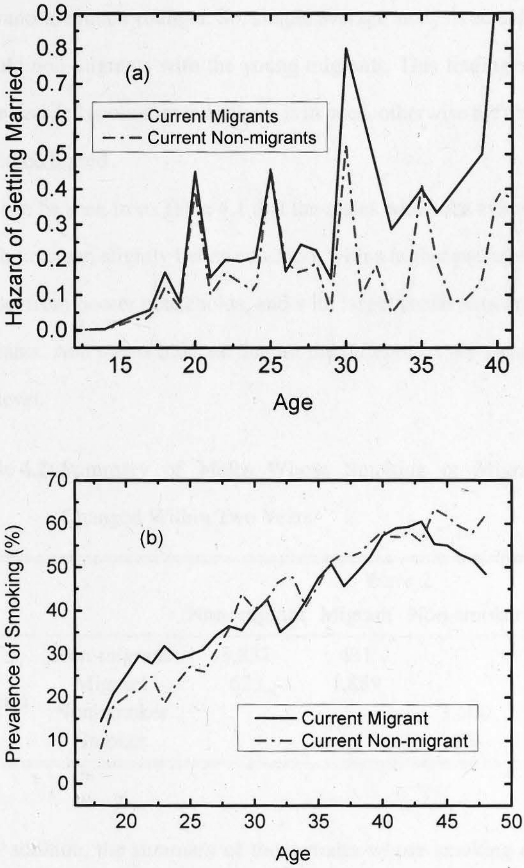

Figure 4.1: Hazard of Smoking and Prevalence by Age in China, Males 18-50 Years (Current Migrants v.s. Current Non-migrants)

migrant and non-migrant is shown in Figure 4.2, where it can be seen that migrants are much younger. So, simple average analysis actually compares the old non-migrants with the young migrants. This finding suggests that more detailed econometric analysis is in need, otherwise the results derived would be biased.

It can be seen from Table 4.1 that the males who have ever migrated are much younger, slightly better-educated, with a higher probability of being single, from poorer households, and with larger social networks than non-migrants. And t-tests indicate that all the differences are significant at the 1% level.

Table 4.2: Summary of Males Whose Smoking or Migration Status Changed Within Two Years

		Wave 2			
		Non-migrant	Migrant	Non-smoker	Smoker
Wave 1	Non-migrant	3,837	431		
	Migrant	623	1,889		
	Non-smoker			3,500	469
	Smoker			95	2,752

In addition, the summary of those males whose smoking or migration status changed within two continuous years are shown in Table 4.2.[2] The

[2]The summary is based on two balanced panel data comprising 6,780 rural males with respective to migration status and comprising 6,816 rural males with respective to smoking status.

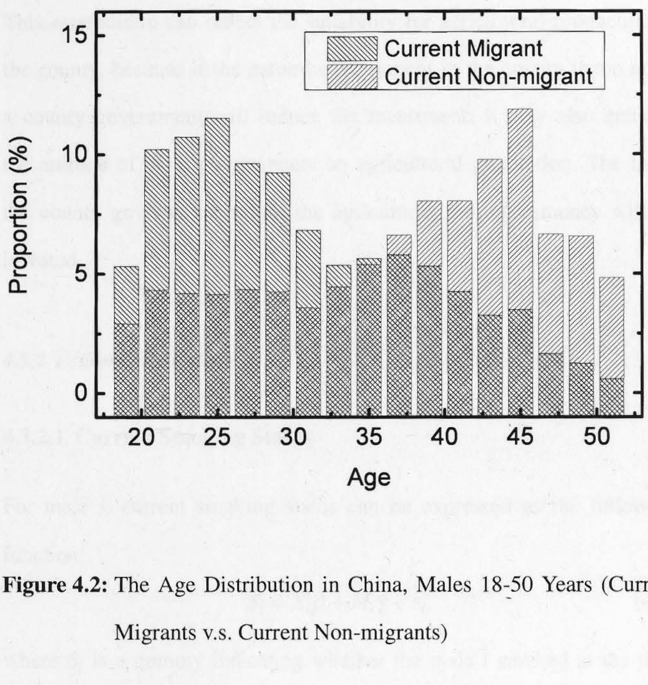

Figure 4.2: The Age Distribution in China, Males 18-50 Years (Current Migrants v.s. Current Non-migrants)

migration status of rural males is quite stable: only about 15% males changed their migration status. The size of the new migrant sample is quite similar to that of return migrants. However, only 95 males quit smoking, while 469 males take up smoking within these two years.

To account for the difference in sending areas of migrants, I employ the overall county government expenditure on Supporting Agriculture Production between 1993 and 2003, taken from China Social and Economic Data at County Level in China which are collected by a group from the College of Economics and Business Administration, Beijing Normal University.

This expenditure can reflect the suitability for agricultural production in the county, because if the natural environment in the county is too poor, a county government will reduce the investment. It may also embody the attitude of local governments on agricultural production. The more the county government values the agriculture, the more money will be invested.

4.3.2 Estimation Strategy

4.3.2.1 Current Smoking Status

For male i, current smoking status can be expressed as the following function:

$$S_i = X_i\beta + M_i\gamma + \varepsilon_i, \tag{4.1}$$

where S_i is a dummy indicating whether the male i smoked at the time of the survey; M_i is a dummy indicating whether male i was a migrant at the time point of the survey. That is, in this study, the migrants are those with rural Hukous who lived in cities when RUMiCI was carried out. According to the answers of participants to the question "Are you currently a regular smoker?", they are classified into two groups - current smokers or current non-smokers. X_i is a vector of other explanatory variables. The key coefficient of interest is γ. The robust standard errors are clustered at the individual level.

Controls include minority status, age and age^2, schooling years, household income per capita, whether married, county or province dummies. I also include the number of friends and relatives greeted by householder during the Chinese New Year to proxy the social networks or social skill. The reason to control this variable is that in Chinese culture, smoking is in fact a social skill. For Chinese, it is very normal to offer cigarettes to a stranger when they first meet. And social skill or network on the other hand played a very essential role in the process of rural-urban migration in China (Giles and Yoo, 2007; Liu et al., 2012). Thus, if failing to control the effect of social networks, the estimate of migration on smoking would be inconsistent. However, the direction of the bias cannot be predicted because the correlation between migration and social networks is not clear. The increase in the size of social networks can enlarge the probability of migration, however can also increase the probability of local labour force participation, which depends on the structure of the increase.

A simple OLS regression provides an inconsistent result because of the endogeneity problem caused by possible omitted variables. The first possible variable is health-status, which is correlated with both migration and smoking status (see e.g. Evans, 1987; US Department of Health, Education, and Welfare, Public Health Service, 1964). It is well known that the health effects of smoking are normally long term, so the impact of missing health status should be large for the older age cohort. In other words, if the sample is restricted to the younger population subgroup, the effect of omitted health status would not be very serious. The other variable is risk-preference (Anderson and Mellor, 2008; Goto et al., 2009). Risk-takers have a higher probability of migration and desire to see the outside world; meanwhile, they are also more likely to smoke in order to seek thrills. For the former, the correlation between M_i and ε_i is negative but positive these two case respectively. Hence, the overall correlation between M_i and ε_i is unclear. Therefore, it cannot be predicted whether the OLS result is over- or under-estimated.

One way to deal with the endogeniety problem is to employ an instrument variable. However, in practice, it is really difficult to find a valid instrument that nobody can question. Therefore, I employ fixed-effect (FE) models to correct for the effect of the time-constant unobserved heterogeneity. Importantly, the longitudinal data structure can also take the ever-smokers into account. In terms of the issue on smoking behaviour, the risk preference, which normally remains unchanged in short term, is the main component of the time-constant unobserved heterogeneity. Specifically, the current smoking status is expressed ar follows.

$$S_{it} = X_{it}\beta + M_{it}\gamma + \nu_i + \varepsilon_{it}, \tag{4.2}$$

where S_{it} is a dummy indicating whether male i smoked at the time point of the survey of the t^th wave ($t \in \{1,2\}$); M_{it} is a dummy indicating whether male i was migrating at the time point of the survey of the t^{th} wave and ν_i is the unobserved time-invariant heterogeneity whose major component is the risk preference. Because the time-interval between the two waves of RUMiCI is only one year, the change in the risk preference, especially related to smoking and migration, may not be large. Furthermore, because it is quite difficult to argue that a male's risk preference follows normal-distribution, the random-effect model is not employed in this study. Finally, unlike OLS model, the time-invariant variables, such as schooling years, minority status, and fixed effects of counties, cannot be controlled.

4.3.2.2 Initiation of Smoking

In order to analyse the effect of migration on the timing of smoking initiation, a proportional hazard model is employed. The hazard of smoking onset at time t is expressed as

$$h_i(t|X_i(t)) = h_0(t)e^{X_i(t)\theta+M_i(t)\gamma}, \tag{4.3}$$

where $h_0(t)$ represents the baseline hazard at year t; $X_i(t)$ is a row of time-variant and time-invariant variables, θ is a vector of coefficients estimated. In this chapter, baseline hazard follows the piecewise form which is the standard and flexible assumption. That is,

$$h_0(t) = \begin{cases} e^{h_1}\ for\ t_0 \leq t < t_1, \\ e^{h_2}\ for\ t_1 \leq t < t_2, \\ \vdots \\ e^{h_n}\ for\ t_{n-1} \leq t, \end{cases} \tag{4.4}$$

The parameters to be estimated include γ, θ, and $h_1, h_2, \cdots h_n$. Considering the males are aged between 18 and 50, n is set to be six, and $t_0, t_1, \cdots, t_{n-1}$

to be 10, 15, 20, 25, 30, and 35 respectively. Then the conditional density function of completed duration of non-smoker can be written as

$$f_i(t|X_i(t)) = h_i(t|X_i(t)) \exp \int_{t_0}^{t} h_i(s|X_i(s))ds. \tag{4.5}$$

The time-invariant explanatory variables include minority status, schooling years, the birth year dummies, and county dummies. The time-variant variable of interest, $M_i(t)$, is a dummy indicating whether male i had ever migrated before year t. That is, for a male without migration experience, the dummy would always be equal to zero. For a male who has migration experience, the dummy is zero before he migrated for the first time and equals one afterwards. The lack of very detailed retrospective data on education prevents us from a complete reconstruction of enrolment histories. Normally, in the rural areas of China, education is continuous until graduation. And according to the education law in China, every child has to get enroled if she or he is older than a certain age, which varies between six and eight years across both time and regions. So, at first, I assume that all males enrol at age six, and I then perform a robustness check by assuming that all of them enrol at age eight. The other controlling variables include schooling years, minority status, social networks,the fixed effects of birth-year and counties.

Finally, note that the estimate of the effect of migration on smoking uptake could be bias because the variable indicating migration is endogenous. This problem will be dealt with in some degree in next chapter.

4.4 Results

4.4.1 Current Status of Smoking

The OLS estimation of the rural-urban migration effect on current smoking status are shown in the first two columns of Table 4.3. Whether the province effects or the county effects are controlled for, the results are quite similar. First of all, the effect of rural-urban migration is insignificant. The estimate of age indicates that the older the male, the higher the probability of smoking. However, this can also interpreted as that the mature birth cohorts are more likely to smoke. Because the estimations are based on panel data with only two waves, these two effects cannot be distinguished. An extra schooling year can reduce the probability of smoking, while marriage or cohabitation increases this probability. However, after controlling for county effect, the effect of being in an ethnic minority becomes insignificant. The reason behind this may be that some counties in China are ethnic minority enclaves, so after controlling for the county fixed-effect, the effect of minority is eliminated. The effects of household income per capita and social networks (which is proxied by the number of friends and relatives greeted by the household head during the Chinese New Year) are marginally significant.

In this study, I employ fixed-effect models to overcome the inconsistency cause by the time-constant unobserved heterogeneity whose main component is the risk preference. It is reasonable to argue that an

Table 4.3: The Effect of Rural-Urban Migration in China on Current Smoking Status, Males 18-50 Years - OLS and FE

	OLS (1)	OLS (2)	FE (3)
Whether migrated currently	-0.00 (0.01)	-0.00 (0.02)	0.03*** (0.01)
Age	0.01** (0.01)	0.01** (0.01)	0.12*** (0.01)
$Age^2/1000$	-0.01 (0.07)	-0.01 (0.07)	-0.97*** (0.19)
Schooling years	-0.02*** (0.00)	-0.02*** (0.00)	
Whether married	0.09*** (0.02)	0.07*** (0.02)	-0.03* (0.02)
Minority status	0.17*** (0.06)	0.12 (0.18)	
Household income per capita (10^3 Yuan)	1.89 (1.25)	2.25* (1.27)	0.68 (0.97)
Social networks	-0.00 (0.00)	0.00* (0.00)	0.00 (0.00)
Constant	0.01 (0.09)	-0.02 (0.10)	-2.54*** (0.24)
County effects	No	Yes	No
Province effects	Yes	No	No
Adjusted R^2	0.11	0.15	
Wald F-statistic for weak instrument			
Observations	14,417	14,417	14,417
Number of males	7,601	7,601	7,601

Note: standard errors in parentheses; ***, **, and * denote significant at 1%, 5%, and 10% respectively.

individual's risk preference does not change with time, particularly in two continuous years. The results are shown in the third column of Table 4.3. The estimation shows that rural-urban migration increases the probability of smoking significantly by about three percent. The coefficients of age and age-squared have the same signs as the OLS results. In addition, the effect of marriage or marriage status is marginally significant and negative. And income and social networks have no significant effect on the current smoking status.

Table 4.4: The Effect of Rural-Urban Migration in China on Current Smoking Status by Birth Cohorts, Males

Birth cohort	18-50 (Full sample)	18-40	18-30	18-25
OLS	-0.01	-0.00	0.03*	0.05***
	(0.01)	(0.01)	(0.02)	(0.02)
Observations	14,417	9,196	5,108	2,852
FE	0.03***	0.04***	0.05***	0.04***
	(0.01)	(0.01)	(0.01)	(0.02)
Number of males	7,601	4,930	2,786	1,621

Note: standard errors in parentheses; ***, **, and * denote significant at 1%, 5%, and 10% respectively; the full results for younger birth cohorts are shown in Table A.10.

It should be pointed out that the results of FE still may be inconsistent because a component of the unobserved heterogeneity - health status - could change with time. However, the correlation between the status of health and smoking for young birth cohorts is weak because the long term effect of smoking on health is much stronger than the short term one. So, the extent of the inconsistency of FE estimations should vary among different birth cohorts. Furthermore, Figure 4.1 also suggests that smoking status varies across different birth cohorts. All of the above prompt me to run the models (OLS and FE) for different birth-year cohorts (see Table 4.4). The OLS estimations show that the effect of migration becomes larger when the old group is excluded. If the sample is restricted to the group aged between 18 and 25, the migration effect is more than five percent, while for this youngest group, the difference between the current migrants and current non-migrants in the prevalence of smoking is 6.14%. Compared with the OLS, the estimates of FE is quite robust for each birth cohort. No matter how I restrict the sample, the effect of migration is about 4 percent, which indicates that the FE results are preferred. Please note that the trend in the effect of rural-urban migration shown in Table 4.4 cannot be simply interpreted as the change in the effect of migration between various birth cohorts because the difference is a combination of the age effect and the birth cohort effect. It is possible that as the young birth cohort ages, the effect of migration for them will be the same as for the mature birth group. Unfortunately, based on two-wave panel data, these two effects cannot be distinguished from each other which guarantee the duration analysis on the effect of migration on smoking initiation in the next subsection.

4.4.2 Initiation of Smoking

The results of the duration model are shown in Table 4.5. The estimations of coefficients, instead of hazard ratio, are reported. It can be seen from column (1) in Table 4.5 that the effect of migration on smoking initiation is significantly positive. Rural-urban migration increases the hazard of the initiation of smoking by 29.69% (= exp(0.26) − 1). Both schooling enrolment and an extra year of schooling postpone the start of smoking. Furthermore, as expected, the baseline hazard increases at first, peaks between 16 and 25 years, and then decreases steadily. When males are at their early teens, the smoking hazard is very low, and then they have a high risk of smoking when they are aged between 16 and 25 because they have been deemed to be adults and no longer under their parents' strict surveillance. After this period, the hazard starts to decline because males who do not start smoking in their 30s or 40s normally are less likely to smoke for the rest of their lives.

Additionally, a check is made of the difference in the effect of migration between age cohorts. After introducing an interaction between the migration and the old birth-year cohort (aged more than 25), it can be seen that compared with the result in the column (1) of Table 4.5, the migration effect for the younger group is more than double while the effect for the older group decreases slightly (see column (2) of Table 4.5). Specifically, rural-urban migration increases the hazard of smoking initiation by 66.53% ($=\exp(0.51)-1$) of those aged less than 25, whereas only 19.72% ($=\exp(0.51-0.33)-1$) for the older birth cohort. The estimations of the other variables and baseline remain the same.

Table 4.5: The Effect of Rural-Urban Migration in China on the Initiation of Smoking by Enrolment Age, Males 18-50 Years

	(1)	(2)	(3)	(4)
Enrolment age	Age 6	Age 6	Age 8	Age 8
Whether migrated	0.26***	0.51***	0.17***	0.35***
	(0.06)	(0.12)	(0.06)	(0.12)
Migration × birth-year cohort (25+)		-0.33**		-0.24*
		(0.14)		(0.14)
Schooling years	-0.02**	-0.02**	-0.02**	-0.02**
	(0.01)	(0.01)	(0.01)	(0.01)
Minority status	0.44	0.44	0.48	0.47
	(0.55)	(0.55)	(0.56)	(0.56)
Enrolment	-0.94***	-0.93***	-1.24***	-1.23***
	(0.12)	(0.12)	(0.07)	(0.07)
Social networks	0.002**	0.002***	0.002**	-0.002**
	(0.001)	(0.001)	(0.001)	(0.001)
Baseline				
h_1 (10-15)	-5.64***	-5.65***	-5.62***	-5.62***
	(0.25)	(0.23)	(0.24)	(0.24)
h_2 (16-20)	-2.53***	-2.53***	-2.68***	-2.68***
	(0.20)	(0.21)	(0.21)	(0.21)
h_3 (21-25)	-2.64***	-2.65***	-3.03***	-3.03***
	(0.21)	(0.21)	(0.21)	(0.21)
h_4 (26-30)	-3.35***	-3.34***	-3.74***	-3.73***
	(0.21)	(0.21)	(0.21)	(0.21)
h_5 (31-35)	-4.82***	-4.81***	-5.20***	-5.19***
	(0.24)	(0.24)	(0.25)	(0.25)
h_6 (36+)	-5.47***	-5.45***	-5.84***	-5.82***
	(0.27)	(0.27)	(0.27)	(0.27)

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	(1)	(2)	(3)	(4)
Enrolment age	Age 6	Age 6	Age 8	Age 8
County effect	Yes	Yes	Yes	Yes
Birth-year effect	Yes	Yes	Yes	Yes
Log-likelihood function value	-12,756.98	-12,753.92	-12,617.59	-12,616.05
Sample Size	6,712	6,712	6,712	6,712

Note: standard errors in parentheses; ***, **, and * denote significant at 1%, 5%, and 10% respectively.

Table 4.6: The Effect of Rural-Urban Migration in China on the Initiation of Smoking by Birth Cohorts, Males

Birth cohort	18-50 (Full sample)	18-40	18-30	18-25
Enroled at age 6	0.26***	0.33***	0.52***	0.75***
	(0.06)	(0.07)	(0.09)	(0.13)
Enroled at age 8	0.17***	0.23***	0.38***	0.60***
	(0.04)	(0.07)	(0.09)	(0.13)
Observations	6,712	4,161	2,270	1,249

Note: standard errors in parentheses; ***, **, and * denote significant at 1%, 5%, and 10% respectively; the full results for younger birth cohorts are shown in Table A.12.

Two robustness checks are as follows. First, I assume that all males enrol at age eight instead of age six. The results are shown in the last two columns of Table 4.5, which indicate that the migration effect is still significantly positive, and it is larger for the younger group. The pattern of results remains unchanged, except that the magnitude of the migration effect is smaller than those when assuming that males enrol at age six. Thus, the results are not sensitive to whether males enrolment at age six or age eight. Secondly, I estimate the migration effect for different birth cohorts and the results are shown in Table 4.6. It can be seen that the effect of migration becomes larger when the old group is excluded. For the youngest group (aged less than 25), the effect of migration is nearly three to four times more than the parameter estimates for the full sample. Thus, the younger birth cohort should be the particular target of the tobacco control policies aiming at the early initiation of smoking.

4.5 Conclusion and Discussion

In this study, I examine the effects of migration on the smoking status and the initiation of smoking in rural China. The OLS results show the correlation between rural-urban migration and smoking status is very weak. However, the results of the fixed-effect model also show that rural-urban migration increases the probability of smoking by about three to four percent. Finally, the duration analysis indicates that migration can accelerate smoking onset. More alarmingly I find that the effect of rural-urban migration on smoking initiation in China is much larger for the younger birth cohort. It should be pointed out that unobserved heterogeneities might play a crucial role in analysis on the effect of migration on the initiation of smoking. As a result, the estimation of the duration analysis may be biased. Therefore, the question - is rural-urban migration a stepping-stone - is not yet answered. In the next chapter, this issue will be investigated.

Chapter 5

Is Rural-Urban Migration a Stepping-Stone to Cigarette Smoking?

Abstract Although the prevalence of smoking has decreased significantly in developed countries, the number of cigarette smokers, the death toll due to smoking, and the effects of passive smoke have all increased rapidly in developing countries. One factor leading to this increase has been the large scale rural-urban migration in developing countries. In this study, I analyse the effect of rural-urban migration on the timing of smoking initiation. In order to identify the causal effect of the migration, I employ a bivariate mixed proportional hazard model. The results show that rural-urban migration can increase the hazard rate of smoking by 32.31%. A more alarming finding is that the effect for the younger birth cohort, who are aged less than 25, is extremely substantial. Specifically, the rural-urban migration can increase the hazard of smoking by about 1.6 times for this particular group. And counterfactual experiments show that although the effect of rural-urban migration on the expected age of smoking onset is not very large, migration can increase the lifetime prevalence of smoking

significantly. The earlier migration starts, the larger its effect on the prevalence of smoking is.

Key words: Rural-urban Migration; Cigarette Smoking; China

5.1 Introduction

The United States Surgeon General warned of the negative health effect of cigarette smoking in 1964 (US Department of Health, Education, and Welfare, Public Health Service, 1964), and this enhanced the public awareness dramatically. Since then, tobacco control has become a public health priority for many governments in the developed world, and a wave of regulation and legislation has followed, including restricting the advertising and promotion of cigarettes, placing warning signs on packaging, increasing the price using taxation, and launching many tobacco control campaigns. As a result, the prevalence of smoking has decreased significantly (Laugesen and Meads, 1991). However, in the developing countries, both the number of cigarette smokers and the death toll caused by smoking and passive smoking has increased rapidly. The Food and Agriculture Organization of the United Nations (2003) estimated that the number of smokers in the world would be around 1.3 billion by 2010, with around 82% located in the developing world. The World Health Organization (2008) estimated cigarette smoking kills 5.4 million people globally each year, and the annual death toll will double by 2030, with more than 80% of those deaths occurring in low-income countries. Besides the negative health effects of smoking, the growing economic costs due to smoking (at both individual and national levels), such as health-care cost and losses in productivity, are substantial. For some developing countries, the gross health-care cost attributed to smoking accounts for as much as 1.1 percent of GDP (Jha and Chaloupka, 2000). Studies also show that many poor smokers spend a significant proportion of their income on tobacco, while cigarette smoking causes nonproportionally high losses in productivity for the poor, therefore tobacco use is a major contributor to a vicious circle of poverty (World Bank, 1999; World Health Organization, 2004).

One challenge faced by tobacco control policies aiming at solving this grim situation is the addictive nature of smoking. Health researchers have found that the earlier the initiation of smoking, the higher the chance of nicotine dependence, thus the greater the difficulties in quitting (Breslau et al., 1993; Breslau and Peterson, 1996; Hegmann et al., 1993; Khuder et al., 1999; Taioli and Wynder, 1991). Research on understanding the factors and the timing of smoking can inform the policies designed to prevent smoking, because it is much easier to avoid starting to smoke than to quit. Researchers have explained for example the family influence (Flay et al., 1994; Gilman et al., 2009; Hill et al., 2005), the effect of television viewing and exposure to smoking in movies (Gutschoven and Bulck, 2005;

Hanewinkel and Sargent, 2007), the impact of advertisement (Henriksen et al., 2010) and the effect of policies, such as tobacco tax and spreading an understanding of tobacco's harmful effects (Douglas and Hariharan, 1994; Zhang et al., 2006) on individual's smoking behaviour.

Along this line, Ding (2011) employed a simple proportional hazard model and showed that rural-urban migrants have a greater risk of starting smoking after migration in China. It is well known that rural-urban migration plays a central role in the economic growth and the urbanization process (Beine et al., 2001; Meng et al., 2010; Yang, 2008). In China, the migration population grew from over 38.9 million in 1997 to about 145 million in 2009 (National Bureau of Statistics of China, 2010; World Bank, 2009). According to the findings of Ding (2011), the significant scale of the labour-related migration from rural to urban areas in developing countries (see e.g. Lall et al., 2006), will cause a huge health burden due to smoking. However, Ding's findings suffer from the endogeneity problem because some factors, for example the risk preference, may be correlated with both the migration and smoking decision. That is, a migrant with a high risk preference may be more likely to migrate to have a look at the world outside, and also may find it easier to initiate smoking in order to seek thrills. So the effect of policy targeting this particular group may be questionable. The other possible cause of endogeneity is that smoking is a type of social skill in many developing countries. As a result, smoking behaviour is positively related to the amount of information obtained from the social networks and therefore may impact the timing and decision of migration. The estimation result would be inconsistent.

The purpose of this study is to investigate whether rural-urban migration is a stepping-stone to cigarette smoking. In order to identify the causal effect of migration on smoking, i.e. to solve these problems mention previously, I apply a bivariate hazard model. Specifically, I model the transitions into cigarette smoking and into rural-urban migration with two single mixed proportional hazard models. The unobserved heterogeneities of these two transitions are permitted to be correlated. The advantage of this methodology is that the identification does not rely on a conditional independence assumption, but the sequence in which events occur. In other words, it is not necessary to have a valid instrument. Instead, the *No Anticipation* assumption, that in this study males would not change the smoking behaviour corresponding to the timing of migration, must be satisfied. Based on the estimation, the question - whether rural-urban migration is a stepping-stone to smoking - can be answered. The answer to this question is crucial to the policy implications. If rural-urban migration is a stepping-stone to smoking, then migrants should be the special target of policies aimed at tobacco control. However, the facts that the Hukous of migrants are registered in rural areas but reside in urban areas, and frequently float among cities, make the implement of any policies trying to following this special group difficult. However, since the majority of them work as sales and service workers, and manual workers (Zhang and

Wu, 2013). It could be an efficient and affective measure for the health authority in urban areas to spread health knowledge of cigarette smoking in construction sites, manufacturing plants, restaurants and etc.

The chapter is structured as follows. The next section reviews the mixed proportional hazard model. Section 5.3 presents econometric models used in the study. Section 5.4 introduces that data used and the statistics summary of the sample used. Section 5.5 discusses the empirical results, and Section 5.6 concludes the chapter.

5.2 Review on the Mixed Proportional Hazard Model

Before introducing the bivariate mixed proportional hazard model used in this study, duration models are reviewed firstly in this section. Finding the applications of hazard models is straightforward in many areas of applied economics, including for example unemployment, job-seeking, drug-use, fertility and mortality (Frijters and van der Klaauw, 2006; Richardson and van den Berg, 2008; van den Berg et al., 2006; van Ours, 2006). There is now widespread acknowledgement that ignoring unobserved heterogeneity in hazard models can bias not only the estimation of the duration dependence but also the effect of observed explanatory variables (van den Berg, 2001). This is because people with high unobserved random components (high susceptibilities) are more likely to experience the event of interest early, so that the sample of individuals survived is a selected one with relatively low random effects (low susceptibilities). So there is a *weeding out effect* (or a *selection effect*) over time.

In a theoretical framework, a hazard function is conditional on the observable ϕ and the unobserved heterogeneities φ, among which the observable is given by a scalar function $\phi = f(X, \beta)$, where X is a vector of individual explanatory variables and β is the vector of the coefficients correspondingly. Moreover, it is assumed that the unobserved heterogeneity φ is a positive time-invariant random effect which is independent of the observable ϕ. Then, the difference observed in the hazard values between the survived respondents with different values of the observable ϕ would include the gap in the unobserved heterogeneity φ. Thus the survived with a large ϕ have on average a small φ, while those with a small ϕ normally have a large φ. If in practice, this hazard function is modelled as a hazard function without any unobserved heterogeneity, i.e. the hazard function is assumed only conditional on the observable, ϕ, but not on the unobserved heterogeneity φ, we would erroneously underestimate the effects of the explanatory variables on the hazard. In other words, the difference between the hazard values due to the observable ϕ is lower than the real difference if the unobserved heterogeneity φ is not taken into account. That is why mixed proportional hazard (MPH) models are widely employed in applied studies.

In order to show this point in a straightforward way, assume that there are two types of persons: one is the *non-smokers* who would never start smoking, and the other one is the *potential smokers* who may start smoking. Also assume that rural-urban migration can increase the hazard of the initiation of smoking. On the one hand, because the *non-smokers* would never start smoking whether ever migrated or not, the probabilities of never starting smoking (the survival curves) for *non-smokers* whether ever migrated or not are the same and keep to be one (see the line in the top of Figure 5.1). On the other hand, because rural-urban migration can increase the hazard of smoking initiation, the survival curve of the *potential smokers* who have ever migrated is always beneath that of the *potential smokers* who never migrated. Additionally assume that the number of the *non-smokers* is the same as that of the *potential smokers*. Then, instead of the straight line in the top and two curves in the bottom, the two curves in the middle can be observed, which indicates that the probabilities of never starting smoking for migrants and non-migrants respectively. Obviously, the difference between these two observed curves is smaller than that of those two curves of the *potential smokers*. Because the difference between the survival rates can roughly measure the effect of rural-urban migration, Figure 5.1 suggests that if ignoring the unobserved heterogeneity, the results would be underestimated.

For some hazard models with specific baseline distributions, the bias due to ignoring unobserved heterogeneity reduces to a rescaling for all the coefficients before the observed variables or a bias only for the constant term. For example, Lancaster (1985) proved analytically that for the MPH

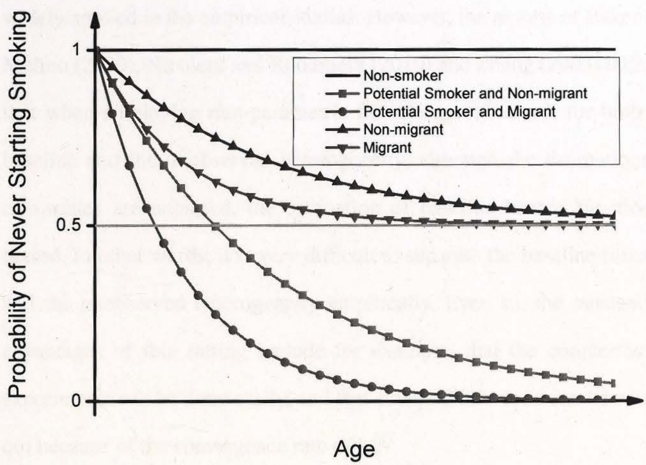


Figure 5.1: An Illustration of the Underestimation due to the Ignorance of the Unobserved Heterogeneity

model with a Weibull distributed baseline, the omission of the unobserved heterogeneity causes a rescaling by a constant factor for all the observable. In contrast, some Monte Carlo studies and empirical studies, such as Trussell and Richards (1985), Ridder (1987), Meyer (1990) and Dolton and von der Klaauw (1995), suggested that employing a non-parametric flexible specification would provide an unbiased estimation of the co-variates coefficients. So, a more sophisticated setting, a stepwise baseline hazard function and an unobserved heterogeneity distribution composed a finite number of mass points which are determined empirically, is widely applied in the empirical studies. However, the reports of Baker and Melino (2000), Nicoletti and Rondinelli (2010) and Zhang (2003) indicate that when employing non-parametric flexible specifications for both the baseline and the unobserved heterogeneity, although the estimations of co-variates are unbiased, the estimation of baseline hazard function is biased. In other words, it is very difficult to separate the baseline function and the unobserved heterogeneity empirically. Even so, the outstanding advantages of this setting include for example, that the counterfactual experiments can be done easily, and that standard inference can be carried out because of the convergence rate of $\sqrt{N}$.

As an extension of the MPH model, the multi-variate mixed proportional hazard (MMPH) model drew much attention from economic researchers because the MMPH model can be used to model the relation between duration variables. Although the applied econometric literature on the MMPH model is abundant, the range of the MMPH model is actually not so large. One popular type focuses on the situation where several durations occur simultaneously and where the realization of one event (the treatment) has an immediate effect on the realizations of the others events (the event of interest). Furthermore, the unobserved determinants for different durations are permitted to be correlated. The correlation between the unobserved heterogeneity indicates that there is an overlap in the susceptibilities to each event. The presence of the correlation is particularly important because the estimation of the causal effect will be biased otherwise. A major advantage of employing the MMPH model is that it is not necessary to have a valid instrument to identify the causal effect of the treatment because the identification does not rely on a conditional independence assumption, but the timing of events, for example the order in which initiation of smoking and migrating to urban areas occurs in this study. Given the difficulties in finding a valid instrument, this feature is particularly valuable. This duration analysis method has been widely used to identify the causal effect of one event on another event. For example, van den Berg et al. (2004) and Abbring et al. (2005) investigated the impact of policy interventions on unemployment durations, and van Ours and Williams (2009) studied the effect of cannabis use on educational attainment. However, this advantage is not costless. In order to identify the causal effect, the assumption of *No Anticipation* must be satisfied. That is, respondents cannot anticipate the timing of the treatment or simply do not work on such information (Abbring and van Den Berg, 2003).

Back to the issue on the effect of rural-urban migration on the initiation of smoking, previous research by Ding (2011) showed that male rural-urban migrants in China start smoking early. However, it may be argued that the estimation is biased because of the selection problem due to ignoring the unobserved heterogeneity. In order to overcome these problems, I model the transitions into cigarette smoking and rural-urban migration using a bivariate mixed proportional hazard model in which the unobserved heterogeneities of these two transitions are assumed to be correlated. Although rural males may anticipate the start time of migration exactly, it seem to be reasonable to assume that they do not change the hazard rate of smoking before the migration is realized. However, smoking is a kind of social skill in China (FlorCruz, 2011) and so rural males are more likely to start smoking before migration in order to enlarge the social networks which may provide valuable information and reduce the cost of migration (see e.g. Zhang and Li, 2003; Zhao, 2003). In other words, the *No Anticipation* assumption may not be satisfied. In this study, this problem is solved by controlling the size of social networks. Thus, with the help of the bivariate mixed proportional hazard model, which is introduced in details in the next section, the causal effect of rural-urban migration on the initiation of smoking is identified.

5.3 Econometric Methodology

The starting point in current analysis is the two single hazard rates of the initiation of smoking and rural-urban migration respectively. Correspondingly, two single hazard models, specifically two mixed proportional hazard models with flexible baseline hazard setting, are employed. The single hazard rate of starting smoking at time t is conditional on the observable $\phi_s = \exp(X'(t)\beta_s + M(t)\gamma_s)$, where $X(t)$ are the characteristics of respondents and $M(t)$ is a time-variant variable indicating the migration status, and the unobserved heterogeneity $\varphi_s = \exp(v_s)$. Specifically,

$$\begin{aligned}\theta_s(t|X(t),M(t),v_s) =&\lambda_s(t)\phi_s\varphi_s \\ =&\lambda_s(t)\exp(X'(t)\beta_s+M(t)\gamma_s)\exp(v_s),\end{aligned} \tag{5.1}$$

where $M(t)$ is a dummy variable equal to one if the male ever migrated prior to or in the current period, and zero otherwise.[1] If he returns to the rural area permanently, $M(t)$ changes from one back to zero. The parameter of interest is γ_s since it indicates whether migration has a positive or negative effect on initiation of smoking. The observable characteristics $X(t)$ includes time-invariant variables (minority group status, schooling years, social networks, county fixed effect, and birth year fixed effect), and a time-variant variable (a dummy variable indicating whether enrolled in school at year t). $\lambda_s(t)$ represents the baseline function. In this study, I model the form of baseline hazard flexibly as a piece-wise function:

$$\lambda_s(t) = \exp(\Sigma_k\lambda_{sk}I_k(t)), \tag{5.2}$$

where k is a subscript for age-interval and I_k is a time-varying dummy variable which is one in k^{th} age interval. $\lambda_s(t)$ is also called as individual duration dependence in some literature. Age ten is assumed to be the time

[1]Alternatively, two variables can be introduced: 1) one indicator equal to one if the individual ever migrated to an urban location in any period prior to the current period and 2) the other equal to one if the individual returned form an urban location back to their rural residence in any period prior to the current one. However, there are two endogenous variables in this setting: the two variables for migration and return respectively. In other words, a triple-variate model would be in need and its computing complexity increases significantly. Thus, I only introduce one variable in this study.

in which this potential exposure to smoking begins. And I distinguish four age intervals (10-15, 16-25, 26-35), with the last interval half open (36+). Because all λ_{sk} are estimated, the constant term is normalized to zero. The unobserved heterogeneity is modelled as a discrete distribution which has two points of support v_{s1} and v_{s2}.[2]

$$\begin{aligned} Pr(v_s = v_{s1}) =& p; \\ Pr(v_s = v_{s2}) =& 1-p, \end{aligned} \tag{5.3}$$

where p is assumed to be $p = \exp(\alpha)/(1+\exp(\alpha))$. Because of the identification condition, v_{s1} is moralized to zero ($v_{s1} = 0$). The two points of support indicates there are two types males who differ in terms of their susceptibilities to smoking conditional on the observable and age. Then, the conditional density function for the completed durations until smoking for the first time can be written as

$$\begin{aligned} f_s(t|X(t),M(t),v_s) =& \theta_s(t|X(t),M(t),v_s) \\ & \exp(-\int_0^t \theta_s(h|X(h),M(h),v_s)\,dh), \end{aligned} \tag{5.4}$$

After integration, the conditional density function for the completed durations until smoking for the first time of all the males can be obtained.

$$f_s(t|X(t),M(t)) = \int_v f_s(t|X(t),M(t),v_s)\,dG_s(v_s), \tag{5.5}$$

where $G_s(\cdot)$ denotes the two point distribution of v_s. In estimation, I allow the duration until smoking to be right censored in order to take into account

[2]The number of support points is decided econometrically. That is, the third point can not be distinguished from the second one.

that some males have not started to smoke at the time of survey but may do so in the future.

Similarly, the single hazard rate of rural-urban migration is modelled in the following way

$$\begin{aligned}\theta_m(t|X(t),M(t),v_m) &= \lambda_m(t)\phi_m\varphi_m \\ &= \lambda_m(t)\exp(X'(t)\beta_m)\exp(v_m),\end{aligned} \tag{5.6}$$

where the observable characteristics $X(t)$ is same as those in the smoking function including minority group status, schooling years, social networks, county dummies, birth year dummies, and a dummy variable indicating whether enrolled in school at year t. And similarly the baseline function is defined as $\lambda_m(t) = \exp(\Sigma_l \lambda_{ml} I_l(t))$. Because in this study the rural-urban migrants are defined as those who migrate to urban areas in order to seek work opportunities, the start age for possible migration is set to be age 15 which is different from that of smoking. And four age intervals (15-20, 21-30, 31-40, and 41+) are identified. Because all λ_{ml} are estimated, the constant is normalized to zero.

Similar to smoking hazard analysis, the unobserved heterogeneity is assumed to be a discrete distribution which has two points of support v_{m1} and v_{m1}.[3]

$$\begin{aligned}Pr(v = v_{m1}) &= q; \\ Pr(v = v_{m2}) &= 1 - q,\end{aligned} \tag{5.7}$$

[3]Again, the number of support points is decided econometrically. That is, the third point can not be distinguished from the second one.

where q is assumed to be $q = \exp(\beta)/(1+\exp\beta)$. Because of the identification condition, v_{m1} is moralized to zero ($v_{m1} = 0$). Correspondingly, there are two types of males who differ in terms of their susceptibilities to migration conditional on the observable and age. The conditional density function for the first rural-urban migration for either type of males can be written as

$$f_m(t|X(t), v_m) = \theta_m(t|X(t), v_m) \\ \exp(-\int_0^t \theta_m(h|X(h), v_m)\,dh), \tag{5.8}$$

After integration, the conditional density function for all the males can be obtained.

$$f_m(t|X(t)) = \int_v f_m(t|X(t), v_m)\,dG_m(v_m), \tag{5.9}$$

where $G_m(\cdot)$ denote the two point distribution of v_m. Because some males have never migrated before at the time of survey but may do so in the future, I allow the duration until migration to be right censored.

By assuming the unobserved heterogeneities are correlated, I employed a bivariate hazard model to investigate the possible existence of stepping stone effects. Both starting rates are specified as the two single hazard models, but now the unobserved heterogeneities, v_s and v_m, are possibly to be correlated, and their joint distribution is denoted as $G(\cdot,\cdot)$. Then the joint density function of the two durations of non-smoke at t_s and non-migrant at t_m can be expressed as

$$f(t_s, t_m) = \int_{v_s}\int_{v_m} f_s(t_s|X, M, v_s) f_m(t_m|X, v_m)\,G(v_s, v_m), \tag{5.10}$$

where $G(\cdot,\cdot)$ is assumed to be a discrete distribution with four mass points (v_{s1}, v_{m1}), (v_{s1}, v_{m2}), (v_{s2}, v_{m1}) and (v_{s2}, v_{m2}) reflecting the assumption of four groups of males conditional on observed characteristics and age with respect to the use of tobacco and migration. The first group of males have relatively high susceptibilities to both smoking and the migration; the second group has a low susceptibility to smoking but a high susceptibility to the migration; the third group has a high susceptibility to smoking, but a low susceptibility to the migration; the last type has low susceptibilities to both smoking and the migration.

And the corresponding probabilities are denoted as:

$$\begin{aligned}
Pr(v_s = v_{s1}, v_m = v_{m1}) &= p_1; \\
Pr(v_s = v_{s1}, v_m = v_{m2}) &= p_2; \\
Pr(v_s = v_{s2}, v_m = v_{m1}) &= p_3; \\
Pr(v_s = v_{s2}, v_m = v_{m2}) &= p_4,
\end{aligned} \tag{5.11}$$

where $0 \leq p_n \leq 1$ $(n = 1, 2, \cdots 4)$. Because the baseline hazard are also estimated I normalize $v_{s1} = v_{m1} = 0$. Furthermore, p_n $(n = 1, 2, \cdots 4)$ is assumed to have a multinomial logit specification: $p_n = \exp(\gamma_n) / \sum_i \exp(\gamma_i)$ and the normalization is $\gamma_1 = 0$. This setting can ensure all the probabilities are positive and sum up to one.

5.4 Data and Stylized Facts

The data used in this study is from the first and second waves of Rural-Urban Migration in China and Indonesia (RUMiCI) because in these two waves, the information on the age of starting smoking and the age of quitting was collected respectively. In the Chinese part of RUMiCI, 8,000 rural households were randomly sampled within the annual income and expenditure survey framework of China's National Bureau of Statistics (NBS). The information was collected at the individual and household level, and more importantly, people's retrospective information of smoking and migration were also collected.

The sample used is restricted to males because the smoking prevalence of females in China is less than three percent. The age range for the males was restricted to 18 to 50 years in 2008 because the main reason for rural-urban migration is to seek jobs. This provided a sample of 6,712 males whose smoking and migration histories can be reliably constructed. Among these 6,712 males, 1,537 were smokers and had migration experience. And the sample used is identical to that used in previous chapter. Furthermore, these 1,537 males compose 385 who started smoking after migration, 1,019 who adversely had been smokers before migration, and 133 who migrated and started smoking in the same year. When regressing, the last group is assumed that migration does not affect the hazard of smoking uptake. In other words, those who started smoking immediately after migration are assumed that they did not smoke because of migration. Thus the effect of migration on smoking could be underestimated.

The age of smoking initiation, the focus of the analysis, is determined by the answers to the question. "At what age did you start smoking?", which asked of all those who has smoked ever. On the other hand, the age of the first migration is collected from responses to the following question, "When did you first migrate for work?", which asked of all those who reported ever migrating. Please note that the definition of migration discussed in this study is labour-related. Particularly, those who reported ever migrating were asked "When was the last time you stayed in your home village continuously for more than three months (or will continue the stay for more than three months)?" If a respondent migrated before and stayed in home village when interviewing, this respondent is regarded as a return migrant. The summary shows that the earliest age for first-time migration is 15; more than 75% migrated for the first time before age 29; and 90% before 36. Then, a time-variant dummy variable indicating migration status can be constructed, which changes from zero to one once the respondent migrates to urban areas for the first time and changes back to zero when the migrant returns to the home village.

Another time-variant variable in the analysis is an *enrolment* dummy. Although the information on the age at which respondents enrolled in primary school is missing and it is true there is some variance in the enrolment age across regions and time in China; all children have to enrol at a certain age, which may vary between six and eight years according to the Chinese Education Law. So, initially I ran all the regression by assuming all the males enrolled at the age six. In this way, the enrolment dummy changes from one to zero once after the age exceeds the sum of schooling years plus six. And later, a robustness check is carried out by assuming the uniform enrolment age is eight.

All the other controls are time-invariant: among these is social networks derived from the question "how many friends did you greet during the last spring festival (of 2009)?" which was answered by household heads. The rest of the controls are straightforward, including minority group status, schooling years, county fixed effect, and birth year fixed effect.

Summary statistics of the data are shown in Table 5.1. It can be seen, on the one hand, that compared with non-migrants, rural-urban migrants are almost seven years younger, but only slightly better-educated in rural China. Both migrants and non-migrants on average completed only compulsory education. The households with migrant member(s) have larger social networks. On the other hand, smokers are about five years older than non-smokers and slightly less-educated. This suggests that the difference between different birth year cohorts in smoking and migration behaviour is very significant. In comparison, the distribution of education is very narrow among the peasants in China. The size of social networks for households of smokers and those of nonsmokers are almost the same.

Table 5.1: Statistic Summary

	Ever migrated Mean (S.d.)	Never migrated Mean (S.d.)	Ever smoked Mean (S.d.)	Never smoked Mean (S.d.)
Age	31.69(8.64)	38.16(8.79)	37.77 (8.45)	32.09(9.23)
Schooling years	8.73(2.15)	8.53(2.31)	8.30(2.12)	8.96(2.29)
Minority status	0.01(0.11)	0.01(0.09)	0.01(0.11)	0.01(0.09)
Social networks	45.74(82.00)	37.45(60.57)	44.23(84.76)	38.79(54.83)
Whether ever smoked	0.45(0.50)	0.53(0.50)		
Starting age of smoking	20.99(3.78)^a	22.22(4.45)^b	21.64(4.19)	
Whether ever migrated			0.47(0.50)	0.55 (0.50)
Starting age of migration		24.68(7.38)	26.27(7.98)^c	23.37(6.52)^d
Sample Size	3,451	3,261	3,243	3,469

Note: the sample size for *a*, *b*, *c* and *d* are 1537, 1706, 1589 and 1914 respectively.

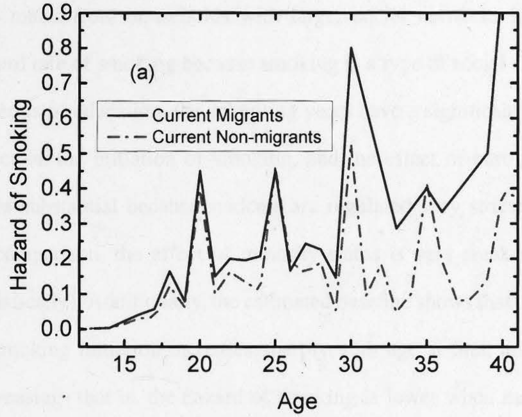
In terms of migration and smoking behaviour, on average more than 51% of rural males have migration experience. And the figures for smokers and non-smokers are about 47% and 55% respectively. On the other hand, the smoking prevalence of the full sample is 49%. And 45% of migrants and 53% of non-migrants smoked before the survey or smoke currently. From this it seems that the rural-urban migration decision is negatively correlated with smoking behaviour. However, as Ding (2011) found, in China the older the birth cohort, the larger the smoking prevalence, while the younger the birth cohort, the larger the likelihood of migration. In other words, both rural-urban migrants and non-smokers are mainly from younger birth cohorts. Thus, the relationship between migration and cigarette smoking should be analysed in the framework of timing of events because a simple summary analysis may reach an incorrect conclusion.

The hazards of starting smoking for males who ever migrated and those who have never migrated are shown in Figure 5.2 (a) respectively. It can be seen that many males start smoking at age 18, 20 25, and 30 years. The possible reason for starting at age 18 and 20 years is that males have finished all the education and are also deemed to be adults. This phenomenon may also be due to reporting bias; however, from the figure, there seems to be no systemic bias between migrants and non-migrants. Furthermore, migrants take up smoking earlier than non-migrants. So, the effect of migration on smoking initiation should be positive. On the other hand, the hazards of migration peak at about 20 years whether smokers or non-smokers. However, the hazard for non-smokers is higher probably because non-smokers are healthier.

5.5 Results and Discussions

5.5.1 Results of the Basic Model

The results for the single hazard of the initiation of smoking are shown in first column of Table 5.2. Firstly, it can be seen that the rural-urban migration has a significant and positive effect on the starting of smoking. The rate at which male rural-urban migrants start to smoke is 32.31% (=



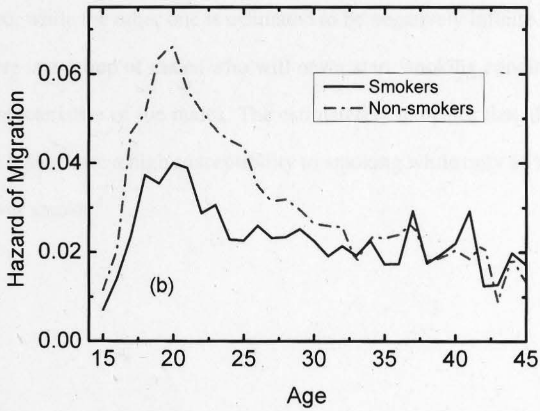


Figure 5.2: The hazards of smoking by migration status and migration in China, Males 18-50 Years (Migrants v.s. Non-migrants)

$\exp(0.28) - 1$) greater than similar male non-migrants. It is not surprising that males from households with larger social networks have a higher hazard rate of smoking because smoking is a type of social skill in China. In terms of education, the schooling years have a significant and negative effect on the initiation of smoking, and the effect of enrolment is even more substantial because students are regulated very strictly in schools. In comparison, the effect of minority status is very weak (insignificant statistically). Additionally, the estimated baseline shows that the likelihood of smoking initiation increases sharply with age at first, and then keeps decreasing- that is, the hazard of smoking is lower when males are aged less than 15 or more than 36. Finally, one of the mass points is set to be zero, while the other one is estimated to be negatively infinite. This means there is a group of males who will never start smoking conditional on the characteristics of the males. The estimated α indicates that about 85% of the males have a high susceptibility to smoking while only 15% males will never smoke.[4]

[4]The difference between the estimated proportion of males who never smoke and that of the raw data could be led to by the problem of censored data.

Table 5.2: The Effect of the Rural-Urban Migration in China on the Initiation of Smoking, Males 18-50 Years - the Single and Bivariate Hazard Models

	The single hazard models		The bivariate hazard model	
	Smoking	Migration	Smoking	Migration
Whether ever migrated	0.28***		0.30***	
	(0.06)		(0.06)	
Schooling years	-0.03***	0.03***	-0.03***	0.04***
	(0.01)	(0.01)	(0.01)	(0.01)
Minority status	0.46	-1.54***	0.52	-3.20***
	(0.59)	(0.59)	(0.58)	(0.60)
Social networks	0.002*	0.001	0.002*	0.001
	(0.001)	(0.001)	(0.001)	(0.002)
Enrolment	-0.93***	-1.54***	-0.92***	-1.49***
	(0.12)	(0.10)	(0.11)	(0.10)
Baseline				
λ_{s1} (10-15 years)	-5.60***		-5.60***	
	(1.15)		(0.81)	
λ_{s2} (16-25 years)	-2.43**		-2.43***	
	(1.15)		(0.80)	
λ_{s3} (26-35 years)	-3.32***		-3.32***	
	(1.10)		(0.81)	
λ_{s4} (36+ years)	-4.90***		-4.90***	
	(1.13)		(0.82)	
λ_{m1} (16-20 years)		-7.85***		-7.78***
		(2.40)		(1.04)
λ_{m2} (21-30 years)		-6.69**		-6.80
		(3.10)		(1.04)
λ_{m3} (31-40 years)		-6.00		-6.27***
		(4.03)		(1.04)
λ_{m4} (41+ years)		-5.57		-5.84***
		(5.16)		(1.04)

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	The single hazard models		The bivariate hazard model	
	Smoking	Migration	Smoking	Migration
Heterogeneity distribution				
α	-1.69***			
	(0.13)			
β		-0.87***		
		(0.04)		
γ_1			-2.50***	
			(0.16)	
γ_2			-1.62***	
			(0.13)	
γ_3			-5.84*	
			(3.12))	
2^{nd} mass point				
v_{s2}	$-\infty$		$-\infty$	
v_{m2}		$-\infty$		$-\infty$
Probability of heterogeneity				
$p = Pr(v_{s1})$	84.40%			
$q = Pr(v_{m1})$		70.51%		
$p_1 = Pr(v_{s1}, v_{m1})$			77.94%	
$p_2 = Pr(v_{s1}, v_{m2})$			6.42%	
$p_3 = Pr(v_{s2}, v_{m1})$			15.41%	
$p_4 = Pr(v_{s2}, v_{m2})$			0.23%	
County effect	Yes	Yes	Yes	Yes
Birth year effect	Yes	Yes	Yes	Yes
Log-likelihood	-12,884.98	-13,777.29	-25,839.12	
Sample Size	6,712	6,712	6,712	

Note: standard errors in parentheses; ***, **, and * denote significant at 1%, 5% and 10% respectively.

The results for the single hazard model of migration are shown in the second column of Table 5.2. Schooling years has a significant and positive effect on the hazard of rural-urban migration, however, the postponement effect of enrolment is very substantial. Furthermore, the effect of social networks on the starting age of migration is insignificant. This result is reasonable because the information and help provided by social networks may increase males' employment opportunities in both rural areas (non-migration) and cities (migration). In addition, the estimated baseline shows that the older the male, the higher the starting rate of migration. So, with respect to rural-urban migration, individual duration is positively dependent. Finally, similar to smoking, one of the mass points is estimated to be negatively infinite. Taking the estimated heterogeneity distribution coefficient into account, we know that about 30% of rural males will never migrate conditional on the characteristics, while 70% of the males have a high susceptibility to migrate.

The estimates of single starting rates can provide a benchmark for assessing the bias arising from failing to account for the potential correlation in the unobserved heterogeneity. The last two columns of Table 5.2 presents the estimates of the bivariate hazard model of the initiation of smoking and rural-urban migration. The pattern of results is very similar to the benchmark model. First, the magnitude of the effect of rural-urban migration on the initiation of smoking is slightly larger than the benchmark model. Second, schooling years has a significant and negative effect on the hazards of smoking, yet it has a positive effect on the starting age of migration. Enrolling at school can decrease both the hazard of starting smoking and that of rural-urban migration. Minority status defers rural-urban migration significantly, but has no significant effect on smoking at all. In contrast, social networks can accelerate the start of smoking but have no significant effect on the timing of migration; and enrolment postpones both migration and smoking substantially. Finally, the baselines estimated are very similar to those from the single hazard regression. The estimation of baseline hazards indicates that the likelihood of smoking initiation is extremely low at the beginning, increases and peaks between 20 and 30 years, and then keeps decreasing; the individual duration is positively dependent with respect to rural-urban migration.

As detailed in the previous section, I allow for the potential correlation between the unobserved heterogeneities which influence smoking onset and rural-urban migration respectively, by using a flexible approach in which the unobserved heterogeneity is assumed to follow a discrete distribution with four mass points. That is, conditional on the observed characteristics there are four groups of males who differ in their susceptibilities to smoking and migration. The first group has a relatively high susceptibility to both smoking and migration; the second group has a low susceptibility to smoking but a high susceptibility to migration; the third group has a high susceptibility to smoking, but a low susceptibility to migration; the last group has low susceptibilities to both smoking and migration. In terms of the distribution of unobserved heterogeneity, the estimates in Table 5.2 indicate that 1) the correlation between the migration and smoking transitions is insignificant; however, since the estimated variances of these two mass-points are both positive and then automatically the covariance of these mass-points is non-zero. And as a result, migration and smoking must be dependent. 2) Conditional on the observable, about 78% of rural males in the sample belong to the group with high susceptibilities to both smoking and migration; only less than 7% belong to the group with a high smoking starting rate and a low migration rate (the latter is actually zero because the second mass point for migration is negatively infinite). And finally, more than 15% belong to the group with no susceptibility to smoking (the second mass point is negatively infinite) but with a high migration starting rate and the size of the group without any susceptibility to either smoking or migration is very limited and only less than 1%. Thus, around 85% (=78%+7%) rural males have a high susceptibility to smoking, while 15% have a low susceptibility, which is very similar to the estimation of the single hazard model of smoking initiation.

Although the bias in the estimation of rural-urban migration caused by ignoring the correlation of the unobserved is not very large, the estimation is still improved which can be seen from the change in the values of likelihood functions increasing from -26,662.27 (=-12,884.98-13,777.29) to -25,839.12. And it can also be seen that the improvement is mainly because the underestimation of the effect of the minority status on the timing of migration is corrected. The other reason is that the distribution of the unobserved heterogeneity with respect to the migration hazard rate is also changed. The proportion of males with a high susceptibility to rural-urban migration increases from 70.51% to 93.35% (=77.94%+15.41%).

In order to show how large is the effect of rural-urban migration on the initiation of smoking in a straightforward way, I conduct a series of counterfactual experiments based on the results in the third column of Table 5.2. At first, the probabilities of having never smoked (the survival rate) for the males with a high susceptibility for various ages are calculated. For those males with a low susceptibility to smoking, it is not necessary to calculate because they will never start smoking and so the survival rate for this particular group is always one. Then, according to the estimated proportion of either type of males, the probability of having never smoked among all the males are calculated. In addition, I assume that there are two types of migrants: Migrants (A) migrate to the cities at age 25 for the first time and return home at age 31;[5] and Migrants (B) migrate at age 16 for the first time and return home at age 31. And all the other characteristics of all the males, including migrants (A), migrants (B) and non-migrants are also set to be the mean of the sample used. The results are shown in Figure 5.3.

From Figure 5.3, it can be seen that the effect of rural-urban migration on the initiation of smoking is very significant whether for the males with a high susceptibility to smoking or all males. First, with respect to males with a high susceptibility to smoking (the three curves in the bottom of

[5] The age of migration and returning is the same as the mean of the sample used

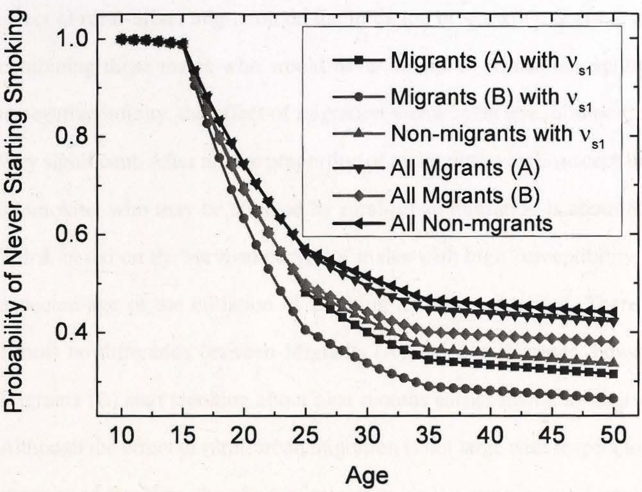

Figure 5.3: The Effect of Rural-Urban Migration in China on Initiation of Smoking, Males 18-50 Years - Counterfactual Experiments

Note: Migrants (A): who migrates at age 25 and returns home at age 31; Migrants (B): who migrates at age 16 and returns home at age 31.

Figure 5.3), the decrease in the probability of never starting smoking (the survival rate) for migrants whether migrates early or lately is much faster than that for non-migrants. And it can also be seen that Migrants (B) are more likely to smoke than Migrants (A), and Migrants (A) are more likely than non-migrants because the survival curve of Migrants (B) is at the bottom, Migrants (A)'s is in the middle while that of non-migrants is on the top. That means that the earlier a male migrates, the larger the effect of rural-urban migration on the initiation of smoking. Second, after combining those males who would never smoke or whose susceptibility is negative infinity, the effect of migration seems to be less, however, still very significant. After all, the proportion of males with a high susceptibility to smoking who may be affected by rural-urban migration is about 85%. Third, based on the survival curves of males with high susceptibility, the expected age of the initiation of smoking are also calculated. There are almost no difference between Migrants (A) and non-migrants, however, Migrants (B) start smoking about nine months earlier than non-migrants. Although the effect of rural-urban migration is not large with respect to the start age of smoking, the effect of migration on the prevalence of smoking is very large: at age 50, 33.62% non-migrants are still non-smoker; 31.47% Migrants (A) have not started smoking; while only 26.52% Migrants (B) have not.

Finally, as mentioned before, because the information on the enrolment age is unavailable, I assume all the males enrolled at the age six. However, in reality, the age for enrolment may vary between six and eight years of age across regions and time. Thus, I carried a robustness check by assuming all the males enrolled at the age 8. The results shown in Table 5.3 indicate that the pattern of the results remain the same. The estimated effect of migration on smoking decreases in the magnitude but is still very significant: rural-urban migration increases the hazard of the initiation of smoking by 14% ($= \exp(0.14) - 1$) to 17% ($= \exp(0.16) - 1$).

Table 5.3: The Robustness Check - the Assumption of Enrolment Age, Males 18-50 Years

	The single hazard model	The bivariate hazard model
Enrolled at age 6		
Whether ever migrated	0.28***	0.30***
	(0.06)	(0.06)
Log-likelihood	-12,884.98	-25,839.12
Enrolled at age 8		
Whether ever migrated	0.16***	0.14***
	(0.06)	(0.06)
Log-likelihood	-12,738.38	-25,750.01
Sample Size	6,712	6,712

Note: standard errors in parentheses; ***, **, and * denote significant at 1%, 5%, and 10% respectively. The other controls include minority status, schooling years, social networks, whether enrolled at school, county fixed effects and birth-year fixed effects.

5.5.2 Distribution of the Heterogeneity

The comparison between the estimated distribution of heterogeneity and the probability of smokers and migrants could arouse concerns that hazard models do not fit the data very well. Specifically, the estimated proportion with a high susceptibility for migration is 93.35% and with a high susceptibility for smoking is 84.57% (see Table 5.2). However, but only 51% and 48% of men in the raw data are observed to ever migrate and to ever smoke. The possible reason is that the censoring problem may affect the estimate of the distribution of heterogeneity. Because it is unknown how many men would eventually migrate, however, was still in their hometowns at the moment of survey, the estimates of the distribution cannot be that accurate. In order to show the possible effect of censoring problem, I excluded the observations aged less than 25 because according to Figure 5.2 many of rural men in China started smoking and migrated before age 25, and then estimated the bivariate hazard model again. However, it should be noted that the setting cannot solve the censoring problem totally, especially for the smoking behaviour. The results of the single hazard model in Table 5.4 show that the after excluding those aged less than 25, 73% of men have a high susceptibility for smoking, however, the results of the bivariate hazard model indicate 63.14% and 82.30% of rural men have a high susceptibility for smoking and migration respectively. Meanwhile, among the rural men aged between 25 and 50, 53.76% and 46.97% of men in the raw data are observed to ever smoke and to ever migrate respectively. It can be seen that the exclusion of young men (censoring observations) makes the estimates fit the data better, particularly for the smoking behaviour. Most importantly, admittedly the estimated proportion of men with a high susceptibility is much larger than the proportion of ever-migrants, however, the estimated effect of migration on the uptakes of smoking is consistent with the previous estimations.

Table 5.4: The Effect of Rural-Urban Migration in China on the Initiation of Smoking, Males 25-50 Years - the bivariate Hazard Model

	The single hazard model	The bivariate hazard model	Raw data
Whether ever	0.21***	0.26***	
migrated	(0.08)	(0.08)	
Mass point			
v_{s2}	$-\infty$	$-\infty$	
v_{m2}		$-\infty$	
Probability of heterogeneity			
$Pr(v_{s1})$	73.36%	63.14%	53.76%
$Pr(v_{m1})$		82.30%	46.97%
Log-likelihood	-12,106.27	-22,959.60	
Observations	5,463	5,463	5,463

Note: standard errors in parentheses; ***, **, and * denote significant at 1%, 5%, and 10% respectively; other controls are not reported.

5.5.3 Difference among Various Birth Cohorts

Ding (2011) found that in China the impact of rural-urban migration is larger for the younger birth cohort although he failed to deal with the endogeneity problem due to the self-selection. In order to examine whether this findings still hold if taking the selection into account, I introduce an interaction term between the migration dummy variable and a birth-cohort dummy variable which is set to be one if male aged more than 25, and zero otherwise.

The birth-cohort dummy is set in this way because males who aged less than 25 in 2008 account for one quarter of the full sample. More crucially, I try to capture the effect of Post 1980, who were born after 2008, in China. Like generation Y in the western world which is a focus of researchers, governments and the public because of Gen Y's unique characteristics, personal value, and life style (Wolburg and Pokrywczynski, 2001), the new Chinese generation, Post 1980, is also a group attracting much attention. Since China implemented a series of radical policies, known as reform and open policies, starting from late 1970s, the economy started to grow quickly. Resulting from this, Post 1980 grew up in a relatively stable and material-prosperous society. They are a hybrid generation serving as a bridge between the Mao's closed China and the new China working as a globalised economic powerhouse and conciliating eastern tradition and western culture (Elegant, 2007). In almost the same period, another famous policy embarked on by the Chinese government is family control policy, known as the one child policy. As a result, the majority of Post 1980 is only child or has only one sibling in their families. They are the centre of their families, and cosseted by their parents and grandparents. They claim that they live for themselves, care their own feelings only, and pay much less attention to the others (Elegant, 2007).

Table 5.5: The Difference in the Effect of Rural-Urban Migration in China on the Initiation of Smoking between Various Birth Cohorts, Males 18-50 Years

	The single hazard model	The bivariate hazard model	
	Smoking	Smoking	Migration
Whether ever migrated	0.50*** (0.12)	0.51*** (0.12)	
Migration × birth cohort (25+)	-0.30** (0.14)	-0.29** (0.14)	
Schooling years	-0.03** (0.01)	-0.03** (0.01)	0.04*** (0.01)
Minority status	0.46 (0.59)	0.51 (0.58)	-3.21*** (0.61)
Social networks	0.002** (0.001)	0.002** (0.001)	0.001 (0.002)
Enrolment	-0.92*** (0.12)	-0.91*** (0.11)	-1.49*** (0.10)
Baseline			
λ_{s1} (10-15 years)	-5.60 (3.68)	-5.60*** (1.12)	
λ_{s2} (16-25 years)	-2.44 (3.64)	-2.43** (1.11)	
λ_{s3} (26-35 years)	-3.31 (3.68)	-3.31*** (1.11)	
λ_{s4} (36+ years)	-4.88 (3.67)	-4.89*** (1.13)	
λ_{m1} (16-20 years)			-7.97*** (0.66)
λ_{m2} (21-30 years)			-6.99*** (0.66)

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	The single hazard model	The bivariate hazard model	
	Smoking	Smoking	Migration
λ_{m3} (31-40 years)			-6.46***
			(0.66)
λ_{m4} (41+ years)			-6.03***
			(0.66)
Heterogeneity distribution			
α	-1.70***		
	(0.13)		
γ_1		-2.51***	
		(0.17)	
γ_2		-1.64***	
		(0.14)	
γ_3		-5.54**	
		(2.28)	
2^{nd} mass point			
v_{s2}	$-\infty$	$-\infty$	
v_{m2}			$-\infty$
Probability of heterogeneity			
$p = Pr(v_{s1})$	84.57%		
$p_1 = Pr(v_{s1}, v_{m1})$		78.18%	
$p_2 = Pr(v_{s1}, v_{m2})$		6.34%	
$p_3 = Pr(v_{s2}, v_{m1})$		15.17%	
$p_4 = Pr(v_{s2}, v_{m2})$		0.31%	
County effect	Yes	Yes	Yes
Birth year effect	Yes	Yes	Yes
Log-likelihood	-12,882.58	-25,836.87	
Sample Size	6,712	6,712	

Note: standard errors in parentheses; ***, **, and * denote significant at 1%, 5% and 10% respectively.

Correspondingly, Post-1980 migrants, as a special group of migrants, are significantly distinct from previous generation migrants. In comparison to previous generations, Post-1980 bear a closer resemblance to urbanites, such as lower endurance for work, stronger aspiration for upward social mobility, and stronger individualism and consumerism (Liu, 2010; Wang, 2010). A recent survey of the new generation migrants (Liang, 2011) shows that 1) more than half do not have long term working contracts; 2) about 45% are unmarried and emotionally very - more than half of them lack emotional support system; 3) they are eager to integrate, but feel discriminated against from the urbanites. The significant dichotomy between the old and new generation of migrants prompted us to carry out the analysis in more detail. The difference between these two groups in terms of motives for migrating, social identity, and intention to stay in the receiving cities are empirically analysed (Dong et al., 2011; Wang, 2001; Zhang, 2008). In contrast few empirical studies have been conducted to examine their behavioural distinction. However, it can be seen that compared with older migrants, Post 1980 migrants are more eager to succeed and to be recognized by the others. So, when facing the environment full of discrimination in cities, they may feel stressed and lonely more strongly, and then are more likely to smoke.

The results after introducing the interaction term of the migration status and birth cohort dummy are shown in Table 5.5. Similar to the results in the previous subsection, the pattern of results of the single hazard model for rural-urban migration is almost the same as that of the bivariate hazard model. It can be seen that for the younger birth cohort, the rate at which male rural-urban migrants start to smoke is 64.87% (= exp(0.50) – 1) greater than similar male non-migrants, while for the older group, the effect is only 22.14% (= exp(0.50 – 0.30) – 1) although the figure is already very large. If taking the correlation between the unobserved into account, the effect of migration is almost the same: 66.53% (= exp(0.51) – 1) for the younger birth cohort and 24.61% (= exp(0.51 – 0.29) – 1) for the older birth cohort. This indicates that the correlation of the unobserved heterogeneities caused hardly any bias in the benchmark models.

Again, in order to show the effect of migration on the timing of smoking initiation for the different birth cohorts, based on the results in Table 5.5, I conduct a series of counterfactual experiments by calculating the probability of never starting smoking for the reference males. The reference males are from five groups: Non-migrants; Mature Migrants (A) who are aged more than 25 and migrate at age 25 for the first time and returns home at age 31; Mature Migrants (B) who are aged more than 25 and migrate at age 16 for the first time and returns home at age 31; Young Migrants (A) who are aged less than 25 and migrate at age 25 for the first time and returns home at age 31; and Young Migrants (B) who are aged less than 25 and migrate at age 16 for the first time and returns home at age 31. A reference male is referred to a male whose characteristics' values, except the migration status, are equal to the means of the characteristics'

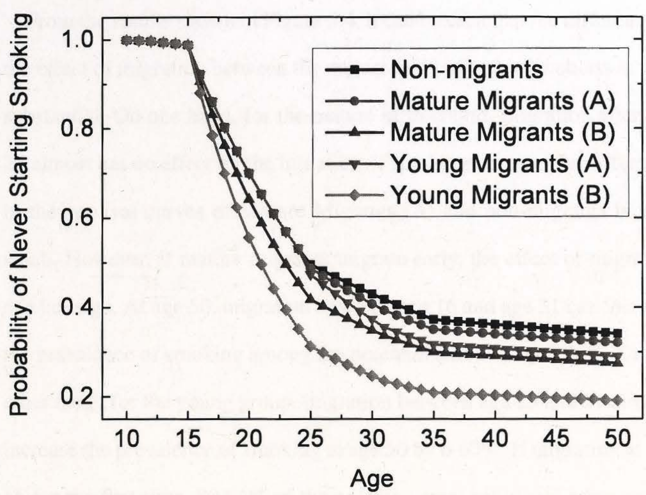

Figure 5.4: The Difference in the Effect of Rural-Urban Migration in China on the Initiation of Smoking between Various Birth Cohorts, Males 18-50 Years - Counterfactual Experiments

Note: Mature: aged more than 25; Young: aged less than 25; Migrants (A): who migrates at age 25 and returns home at age 31; Migrants (B): who migrates at age 16 and returns home at age 31.

values of the sample used. In addition, a reference male is assumed to have a high susceptibility to smoking and so is a potential smoker. After all, rural-urban migration has no impact on the timing of smoking for a male with low susceptibility to smoking because he would never start smoking.

From the results shown in Figure 5.4, it can be seen that the difference in the effect of migration between the mature and young birth cohorts is very substantial. On one hand, for the mature birth cohort, migration after age 25 almost has no effect on the initiation of smoking because the difference in the survival curves of Mature Migrants (A) and non-migrants is very small. However, if mature migrants migrate early, the effect of migration can be large. At age 50, migration between age 16 and age 31 can increase the prevalence of smoking among the potential smokers by 5.06%. On the other hand, for the young group, migration between age 25 and 31 already increase the prevalence of smoking at age 50 by 6.60%. If migrating at age 16 for the first time, 80.84% of the potential smokers would have started smoking before age 50, which is 14.90% more than that of non-migrants.

Furthermore, I excluded the mature observations step by step in order to demonstrate how the migration effect varies among different birth cohorts. The results of single starting rates of smoking for different birth cohorts are shown in Table 5.6. I only report the parameter estimates for variables of main interests, including migration status and the proportions of heterogeneities. It can be seen that excluding the mature observations enhances the effect of migration on smoking tremendously. For the full sample, migration can increase the rate at which males start to smoke by 32.31% ($= \exp(0.28) - 1$), while for the males aged less than 40, the effect is as large as 47.70% ($= \exp(0.39) - 1$). Among males aged less than 30, the figure increases to 91.55% ($= \exp(0.65) - 1$) and for the youngest group (males aged less than 25), the hazard of smoking of migrants is 1.64 ($= \exp(0.97) - 1$) times larger than that of non-migrants. Meanwhile, the proportion of males who would never start smoking increases from about 15.60% to about 53.61%.

Table 5.6: The Effect of Rural-Urban Migration in China on the Initiation of Smoking by Difference Birth Cohorts, Males 18-50 Years - the Single Hazard Model

Birth cohort	18-50 (Full sample)	18-40	18-30	18-25
Whether ever	0.28***	0.39***	0.65***	0.97***
migrated	(0.06)	(0.07)	(0.10)	(0.13)
Mass point				
v_{s2}	$-\infty$	$-\infty$	$-\infty$	$-\infty$
Probability of heterogeneity				
$Pr(v_{s1})$	84.40%	71.01%	56.74%	46.39%
$Pr(v_{s2})$	15.60%	28.99%	43.26%	53.61%
Log-likelihood	-12,884.98	-7,224.25	-3,130.36	-1,493.61
Observations	6,712	4,161	2,270	1,249

Note: standard errors in parentheses; ***, **, and * denote significant at 1%, 5%, and 10% respectively.

The results of the bivariate hazard model for different birth cohorts are shown in Table 5.7. For different birth-year groups, the pattern of estimates is quite similar to that from the models of the single hazard models which ignore the correlation between the unobserved. However, the results are still very informative, because the four mass points can be empirically

Table 5.7: The Effect of Rural-Urban Migration in China on the Initiation of Smoking by Difference Birth Cohorts, Males 18-50 Years - the Bivariate Hazard Model

Birth cohort	18-50 (Full sample)	18-40	18-30	18-25
Whether ever	0.30***	0.42***	0.65***	1.00***
migrated	(0.07)	(0.08)	(0.10)	(0.14)
Mass point				
v_{s2}	$-\infty$	$-\infty$	$-\infty$	$-\infty$
v_{m2}	$-\infty$	-3.85***	-3.36***	-0.04
	-	(0.59)	(0.43)	(0.09)
Probability of heterogeneity				
$p_1 = Pr(v_{s1}, v_{m1})$	77.94%	63.57%	54.17%	0.06%
$p_2 = Pr(v_{s1}, v_{m2})$	6.42%	7.34%	2.57%	44.89%
$p_3 = Pr(v_{s2}, v_{m1})$	15.41%	27.75%	41.38%	55.05%
$p_4 = Pr(v_{s2}, v_{m2})$	0.23%	1.35%	1.89%	0.00%
Log-likelihood	-25,839.11	-16,690.83	-8,271.86	-4,223.89
Observations	6,712	4,161	2,270	1,249

Note: standard errors in parentheses; ***, **, and * denote significant at 1%, 5%, and 10% respectively.

identified and the sizes of the corresponding four groups can be calculated. During the process of excluding the older group step by step, the change trend of the unobserved structure among different birth cohorts can be shown. The second mass point for smoking is always negatively infinite no matter what sample is used, however, the second mass point for migration changes from negative infinity to a negative finite number initially, and finally to zero for the youngest group whose ages are less than 25 years.

In other words, the four-point distribution of the unobserved heterogeneity degenerated to two-point one for this particular group. The proportion of rural males who would never start smoking steadily increases from less than 16% to more than 50%; meanwhile, the proportion of rural males who have low susceptibilities to migration declines from about 7% to none. However, although the estimated proportion of those who have no susceptibilities to smoking among the youngest group is very high, it does not mean the proportion of those who will never smoke is also high because the occurrence of right censoring is extremely high for this young birth cohort. From this point, the findings in this study suggest that the situation of tobacco control among the youngest birth cohort is even grimmer.

5.6 Conclusion

In this study, I investigate the stepping-tone effect of rural-urban migration on smoking onset.Bivariate mixed proportional hazard models are applied to identify the causal effect between rural-urban migration and smoking, in contrast to previous studies that relied on panel data methodologies or on an instrument variable approach. The estimation shows that rural-urban migration has a stepping-stone effect on the initiation of smoking, whether or not the correlation between the unobserved heterogeneities is permitted. Rural-urban migration can increase the hazard of the initiation of smoking by 32.31%. Although the effect of rural-urban migration on the starting age of smoking is not very large, migration does increase the prevalence of smoking significantly. Detailed investigations shows that the effect of migration on smoking onset is extremely substantial for the youngest birth cohort who are aged less than 25. Meanwhile, the proportion of males with a high susceptibility to smoking decreases when the mature respondents are excluded gradually. However, this increase cannot be interpreted as that the proportion of males who would never start smoking in their lives among the youngest group is larger, but that the proportion of males who had never start smoking before the survey among the youngest group is larger. In the future, they are still possible to start smoking. So, the reality could be grimmer than what the results show.

This study demonstrates that the effect of migration on smoking is extremely large for the younger group which is the focus of the research on both migration and smoking. Combining the fact that the scale of rural-urban migrants in developing countries is immense, the urgency of implementation of tobacco control policies towards migrants is obvious. Governments and health authorities should launch public campaigns to raise migrants' awareness of the dangers of passive smoking and the opportunity costs of smoking, and make smoking less acceptable among migrants, particular the young migrants. In addition, Because the rural-urban migrants drift from place to place frequently, it is difficult to launch public campaigns aimed at migrants in urban areas. Intervention in smoking behaviour before migrating, therefore, may be an option.

Chapter 6

Conclusion

This thesis has explored three self-contained, but related issues on the effect of rural-urban migration on: (1) fertility behaviour, (2) marriage behaviour, and (3) smoking behaviour. The first two issues are investigated in Chapter 2 and Chapter 3 respectively. The last one is discussed in Chapter 4 and Chapter 5. The main findings of the four chapters are summarized below.

6.1 Are the Rural-Urban Migrants the *Culprits* of Births Out of Quota?

Chapter 2 focuses on the effect of rural-urban migration on the fertility behaviour of migrants, i.e., the fertility rate and the timing of the first birth.

The results of the IV approach show that the rural-urban migration significantly reduces the number of births of those who migrate as a result of extreme rainfall events. After migration, the fertility of a rural woman decreases by 0.81 which is very large, compared with the mean fertility rate of 1.51 for married women in the sample used in this study.

Although the proportion of the women whose migration is affected by an extreme rainfall event in this study is not very large, the magnitude of the treatment effect is quite large compared with the average fertility rate of rural women.

The results of a proportional hazard models show that the correlation between migration and the timing of first birth among the married females is very weak, however it becomes significant and negative after including unmarried women. The introduction of unmarried women addresses the selection with marriage issue. Further, after controlling the marriage status, the effect of migration disappears. These findings suggest that migration may postpone the first birth by deferring the marriage, an issue addressed in Chapter 3.

Overall, rural-urban migration reduces the number of births for rural women, and delays the timing of the first birth. These results suggest that the rural-urban migrants are not to blame for giving births outside the quota stipulated by the family planing regulations in China at least if rural births are used to the relevant comparison.

6.2 Do Rural-Urban Migrants Change the Timing of the First Marriage?

Chapter 3 takes advantage of the third wave of RUMiCI, in which the information on the age of the first marriage is collected, to analyse the effect of the rural-urban migration on the timing of the first marriage.

The results of a bivariate mixed proportional hazards model show that the male migrants marry four months earlier than similar non-migrants, while rural female migrants marry four months later than their non-migrant counterparts. Chapter 2 reveals that the rural-urban migration postpones the timing of the first birth by about seven months, thus the delay in the first marriage due to migration accounts for more than half of the postponement of the first birth.

The juxtaposition of the facts that the effect of rural-urban migration on the hazard of the first marriage is substantial and that the effect of rural-urban migration on the first marriage age is very small creates a tension. The most likely reason is that the hazard of firs marriage is extremely high. Taking females as an example, the hazard of the first marriage is still quite large even when it is decreased by about 25% after migration. As a result, the effect of migration on the first marriage age is not very large because women have already married before migration takes effect.

6.3 How Rural-Urban Migration Affects Cigarette Smoking Behaviour?

Chapter 4 examines the effects of the rural-urban migration on the smoking status and the initiation of smoking in China. By applying an instrumental variable approach, I found a significant and positive effect of migration on current smoking status, although the IV results are too large to be trusted. Further, the results of the fixed-effect models confirm that rural-urban migration increases the probability of smoking by about 3 percent robustly. Finally, the duration analysis indicates that migration can accelerate the hazard of smoking onset by 5.13% to 8.32%. More alarmingly I find that the migration effect on smoking initiation is much larger for the younger birth cohorts who are aged less than 25.

However, the ignorance of the unobserved heterogeneity may bias the estimation of the duration analysis in Chapter 4. So, in Chapter 5, a bivariate mixed proportional hazard model is applied to identify the causal effect between rural-urban migration and smoking. In this way, the hypothesis that the rural-urban migration is a stepping-stone to smoking can be tested. The estimation results show that rural-urban migration in China does have a stepping-stone effect on the initiation of smoking and the bias caused by the ignorance of the correlation between the unobserved heterogeneities on the estimation is not serious. Specifically, the rural-urban migration can increase the hazard of the initiation of smoking by 32.31%. Counterfactual experiments reveal that although the effect of rural-urban migration on the starting age of smoking is not very large, migration does increase the prevalence of smoking significantly. Further, detailed investigations show that the effect of migration on smoking onset is extremely substantial for the younger birth cohort who are aged less than 25.

6.4 Policy Implications

The thesis conclusions suggest that in China rural-urban migration does change the behaviour of migrants significantly. Taking the unprecedented scale of the rural-urban migrants into consideration, the changes in the behaviour of rural population due to migration have tremendous effects on the society and economy in China. Thus, Chinese government should make corresponding adjustments in the policy design.

In terms of fertility and marriage behaviour, the concern of governments that rural-urban migrant give birth out of quota is not necessary because female migrants give fewer birth and have the first child later than female non-migrants. The other concern of governments that the stability and harmony of society may be affected due to the delay in marriage age of migrants is not necessary either because the effect of rural-urban migration on the first marriage age is very small. Combining these two pints above, it is suggested that the relaxation in the restriction on rural-urban migration will not make the overall population soar, or endanger the stability of the society by deferring the first marriage age.

The analysis of smoking behaviour reveals that if migrants' smoking behaviour continues in China, the damage to human capital and the country's health burden will escalate. Thus, the rural-urban migrants need to be particularly targeted when designing tobacco control policies because the effects of migration on the smoking prevalence rate and smoking initiation for this group are extremely substantial. Possible policy advice includes, (1) special supports should be provided to the rural-urban migrants in order to reduce their loneliness and stressfulness, both of which are the main factors leading to smoking; (2) urban residents should be educated to respect migrants so that they will not deem migrants as second-class citizens, and should involve them in social activities; (3) governments and health authorities should launch public campaigns to raise migrants' awareness on the dangers of smoking and make smoking less acceptable among migrants.

Appendix A

Supplementary Tables

Table A.1: The First Stage Results of IV Estimations in Chapter 2

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Whether any extreme rainfall event occurred	0.04***	0.06***	0.06***	0.05***	0.05***	0.04***	0.04***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Whether married		-0.04**	-0.03*	-0.03	-0.03	-0.03	-0.03
		(0.00)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Birth order	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Minority status	0.10	0.09	0.09	0.10	0.09	0.09	0.09
	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)
Schooling years	0.00*	-0.01***	-0.01***	-0.01***	-0.01***	-0.01***	-0.01***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Age<20	-0.02***	-0.03***	-0.03***		-0.03***	-0.03***	
	(0.01)	(0.00)	(0.00)		(0.00)	(0.00)	
Age$20-30$	-0.02***	-0.01***	-0.02***	-0.02***	-0.02***	-0.02***	-0.02***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

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Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Age> 30	-0.02***	-0.02***	-0.02***	-0.02***	-0.02***	-0.02***	-0.02***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
From a cadre family	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Household income	0.00	0.05*	0.05	0.05	0.05*	0.05	0.05
(10^5 RMB yuan)	(0.04)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Terrain (Reference group: plain)							
Hills	-0.01	0.00	0.00	0.00	0.00	0.00	0.00
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Mountain	0.03	0.05*	0.05*	0.03	0.05*	0.05*	0.03
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
From a poor county	-0.02	-0.01	-0.02	-0.02	-0.01	-0.02	-0.02
or township	(0.03)	(0.02)	(0.02)	(0.02)	(0.01)	(0.02)	(0.02)
Fertility policy index	0.09	-0.28**	-0.28**	0.21	-0.26*	-0.25*	0.18
	(0.16)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)

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Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Constant	0.66***	1.33***	1.35***	0.55***	1.31***	1.33***	0.61***
	(0.23)	(0.20)	(0.20)	(0.21)	(0.20)	(0.20)	(0.21)
County fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4,818	6,748	6,605	6,077	6,748	6,605	6,077
R-squared	0.24	0.25	0.25	0.27	0.25	0.25	0.27

Note: standard errors in parentheses; ***, **, and * denote significant at 1%, 5%, and 10% respectively;

(1) married sample & the age span of the instrument is 16 to 25 years;

(2) full sample & the age span of the instrument is 16 to 25 years;

(3) full sample excluding females aged less than 18 & the age span of the instrument is 16 to 25 years;

(4) full sample excluding females aged less than 20 & the age span of the instrument is 16 to 25 years;

(5) full sample & the age span of the instrument is 16 to 22 years;

(6) full sample excluding females aged less than 18 & the age span of the instrument is 16 to 22 years;

(7) full sample excluding females aged less than 20 & the age span of the instrument is 16 to 22 years.

Table A.2: The Full Results of the Robustness Checks - the Validity of the Instrumental Variable in Chapter 2

Variables	(1)	(2)	(3)	(4)	(5)
Whether migrated	-0.81**	-0.82**	-0.98**	-1.01**	-1.07*
	(0.35)	(0.41)	(0.45)	(0.49)	(0.59)
Whether married	0.83***	0.85***	0.83***	0.83***	0.85***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Birth order	-0.01**	-0.01*	-0.01**	-0.01**	-0.01*
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Minority status	0.04	0.05	0.06	0.06	0.07
	(0.14)	(0.14)	(0.15)	(0.15)	(0.16)
Schooling years	-0.01**	-0.01*	-0.01**	-0.01**	-0.01*
	(0.01)	(0.00)	(0.01)	(0.01)	(0.01)
Age < 20	0.03**		0.02	0.02	
	(0.01)		(0.01)	(0.01)	
Age $20-30$	0.03***	0.03***	0.03***	0.03***	0.02**
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Age > 30	0.03***	0.03***	0.03***	0.03***	0.03**
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
From a cadre family	-0.06**	-0.06**	-0.06*	-0.06**	-0.06*
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Household income	0.01	0.01	0.03	0.02	0.02
(10^5 RMB yuan)	(0.05)	(0.06)	(0.06)	(0.06)	(0.06)
Terrain (reference group: Plains)					
Hills	0.05	0.05	0.05	0.05	0.05
	(0.03)	(0.03)	(0.03)	(0.03)	(0.04)
Mountains	0.17***	0.16***	0.17***	0.18***	0.17***
	(0.04)	(0.05)	(0.05)	(0.05)	(0.05)
From a poor county	-0.01	-0.01	-0.01	-0.01	-0.01
or township	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Fertility policy index	-0.04	0.01	-0.13	-0.16	-0.13
	(0.29)	(0.31)	(0.34)	(0.36)	(0.40)

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Variables	(1)	(2)	(3)	(4)	(5)
Constant	-0.24	-0.35	0.04	0.13	0.09
	(0.70)	(0.79)	(0.87)	(0.95)	(1.10)
County fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	6,605	6,077	6,748	6,605	6,077
F-statistic for weak instruments	19.12	14.64	12.42	11.11	8.19

Note: standard errors in parentheses; ***, **, and * denote significant at 1%, 5%, and 10% respectively;

(1) full sample excluding females aged less than 18 & the age span of the instrument is 16 to 25 years;

(2) full sample excluding females aged less than 20 & the age span of the instrument is 16 to 25 years;

(3) full sample & the age span of the instrument is 16 to 22 years;

(4) full sample excluding females aged less than 18 & the age span of the instrument is 16 to 25 years;

(5) full sample excluding females aged less than 20 & the age span of the instrument is 16 to 25 years.

Table A.3: The Robustness Checks - Older Birth Cohorts in Chapter 2

Variables	(1)	(2)
Whether migrated	-0.07**	-0.07*
	(0.03)	(0.04)
Whether married	1.60***	2.10***
	(0.19)	(0.36)
Birth order	-0.02**	-0.01
	(0.01)	(0.01)
Minority status	-0.14	-0.17
	(0.19)	(0.22)

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Variables	(1)	(2)
Schooling years	-0.01***	-0.01**
	(0.00)	(0.00)
Age > 30	0.05***	0.06***
	(0.00)	(0.01)
From a cadre family	-0.05	-0.07
	(0.04)	(0.05)
Household income	0.31***	0.23**
(10^5 RMB yuan)	(0.08)	(0.10)
Terrain (reference group: Plains)		
Hills	0.01	0.05
	(0.05)	(0.06)
Mountains	0.14**	0.20**
	(0.06)	(0.08)
From a poor county	0.05	0.10
or township	(0.05)	(0.06)
Fertility policy index	1.08***	1.52***
	(0.28)	(0.46)
Constant	-3.53***	-5.10***
	(0.45)	(0.86)
County fixed effects	Yes	Yes
Observations	2,926	1,785
Adjusted R^2	0.42	0.46

Note: standard errors in parentheses; ***, **, and * denote significant at 1%, 5%, and 10% respectively;

(1) females aged between 35 and 45 years;

(2) females aged between 40 and 45.

Table A.4: The Full Results of the Effect of Pre-Migration in Chapter 2

Variables	Enrolled at Age 6	Enrolled at Age 8	Enrolled at Age 6	Enrolled at Age 8
The *n*th year before migration:				
$n = 5$	-0.20	-0.18	-0.23*	-0.21
	(0.14)	(0.14)	(0.14)	(0.14)
$n = 4$	0.10	0.12	0.08	0.10
	(0.13)	(0.13)	(0.13)	(0.13)
$n = 3$	-0.24	-0.24	-0.25	-0.25
	(0.16)	(0.16)	(0.16)	(0.16)
$n = 2$	-0.17	-0.16	-0.18	-0.16
	(0.17)	(0.17)	(0.17)	(0.17)
$n = 1$	-0.22	-0.20	-0.23	-0.20
	(0.18)	(0.18)	(0.18)	(0.18)
Migrated	-0.30***	-0.33***		
	(0.06)	(0.06)		
Migrated × Pre 1970			0.08	0.08
			(0.13)	(0.13)
Migrated × Post 1970			-0.30***	-0.31***
			(0.08)	(0.08)
Migrated × Post 1980			-0.47***	-0.53***
			(0.09)	(0.09)
Birth order	0.01	0.01	0.01	0.01
	(0.01)	(0.01)	(0.01)	(0.01)
Schooling years	-0.03***	-0.02***	-0.03***	-0.02***
	(0.01)	(0.01)	(0.01)	(0.01)
Enrolment	-1.90***	-2.56***	-1.94***	-2.59***
	(0.41)	(0.24)	(0.41)	(0.24)
Minority status	-0.14	-0.10	-0.16	-0.12
	(0.27)	(0.27)	(0.28)	(0.28)
From a poor county or township	0.09	0.09	0.10	0.10
	(0.07)	(0.07)	(0.07)	(0.07)

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Variables	Enrolled at Age 6	Enrolled at Age 8	Enrolled at Age 6	Enrolled at Age 8
Terrain (reference group: Plain)				
Hill	0.07	0.07	0.08	0.07
	(0.07)	(0.07)	(0.07)	(0.07)
Mountain	0.23**	0.22**	0.23**	0.22**
	(0.09)	(0.09)	(0.09)	(0.09)
Generation (reference group: Pre 1970)				
Post 1980	-0.69***	-0.64***	-0.60***	-0.53***
	(0.06)	(0.06)	(0.07)	(0.07)
Post 1970	-0.09**	-0.08**	-0.07*	-0.07*
	(0.04)	(0.04)	(0.04)	(0.04)
Baseline				
h_{01} (Age 16-19)	-6.02***	-5.46***	-6.03***	-5.47***
	(0.17)	(0.17)	(0.17)	(0.17)
h_{02} (Age 20)	-2.51***	-2.55***	-2.51***	-2.56***
	(0.16)	(0.16)	(0.16)	(0.16)
h_{03} (Age 21)	-1.85***	-1.94***	-1.86***	-1.95***
	(0.16)	(0.16)	(0.16)	(0.16)
h_{04} (Age 22)	-1.24***	-1.32***	-1.25***	-1.33***
	(0.15)	(0.15)	(0.15)	(0.15)
h_{05} (Age 23)	-1.06***	-1.14***	-1.06***	-1.14***
	(0.15)	(0.15)	(0.15)	(0.15)
h_{06} (Age 24)	-0.81***	-0.90***	-0.82***	-0.91***
	(0.15)	(0.15)	(0.15)	(0.15)
h_{07} (Age 25)	-0.76***	-0.85***	-0.77***	-0.86***
	(0.16)	(0.16)	(0.16)	(0.16)
h_{08} (Age 26)	-0.71***	-0.80***	-0.73***	-0.82***
	(0.16)	(0.16)	(0.16)	(0.16)
h_{09} (Age 27)	-0.78***	-0.87***	-0.80***	-0.89***
	(0.17)	(0.17)	(0.17)	(0.17)
h_{10} (Age 28)	-0.80***	-0.88***	-0.81***	-0.90***
	(0.18)	(0.18)	(0.18)	(0.18)
h_{11} (Age 29)	-0.98***	-1.06***	-0.99***	-1.08***
	(0.20)	(0.20)	(0.20)	(0.20)

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Variables	Enrolled at Age 6	Enrolled at Age 8	Enrolled at Age 6	Enrolled at Age 8
h_{12} (Age 30)	-1.54***	-1.62***	-1.55***	-1.64***
	(0.27)	(0.27)	(0.27)	(0.27)
h_{13} (Age 31+)	-1.59***	-1.66***	-1.61***	-1.68***
	(0.20)	(0.20)	(0.20)	(0.20)
County fixed effect	Yes	Yes	Yes	Yes
No. of observations	5,770	5,770	5,770	5,770
Log-likelihood	1,389.43	1,479.74	1,394.97	1,486.58

Standard errors in parentheses; ***, **, and * denote significant at 1%, 5% and 10% respectively.

Table A.5: The Effect of Pre Rural-Urban Migration in China, Males 18-40 Years & Females 16-40 Years in Chapter 3

	Male		Female	
Variables	Marriage (1)	Migration (2)	Marriage (3)	Migration (4)
The s^{th} year before migration				
The 5th year	-0.03		-0.17	
	(0.13)		(0.14)	
The 4th year	0.11		0.15	
	(0.13)		(0.13)	
The 3rd year	0.05		-0.05	
	(0.14)		(0.14)	
The 2nd year	-0.07		-0.05	
	(0.14)		(0.15)	
The 1st year	-0.13		0.15	
	(0.15)		(0.15)	
Migration	0.18**		-0.29***	
	(0.09)		(0.08)	

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	Male		Female	
Variables	Marriage (1)	Migration (2)	Marriage (3)	Migration (4)
Return migration	-0.07		-0.01	
	(0.18)		(0.20)	
Marriage status		0.15		-0.03
		(0.09)		(0.09)
Minority status	0.68	-2.00***	-0.14	-0.59
	(0.42)	(0.69)	(0.32)	(0.61)
Schooling years	-0.05***	0.06***	-0.09***	0.08***
	(0.01)	(0.01)	(0.01)	(0.02)
Birth order	-0.04**	0.01	-0.05**	-0.01
	(0.02)	(0.02)	(0.02)	(0.03)
Enrolment	-1.25***	-1.02***	-1.28***	-1.22***
	(0.33)	(0.12)	(0.30)	(0.16)
Social networks	0.00	0.00	0.00	0.00
	(0.75)	(1.91)	(1.36)	(1.00)
Post-1980[a]	-0.83***	1.55***	-0.40***	1.89***
	(0.07)	(0.08)	(0.06)	(0.10)
Sex ratio	-0.75**	0.34	-0.51*	0.01
	(0.29)	(0.29)	(0.27)	(0.38)
Average schooling years of males	0.86** (0.36)			
Average schooling years of females			-0.24 (0.25)	
Average schooling years of individuals		-1.79*** (0.32)		-1.80*** (0.48)
Terrain (reference group: Plains)				
Hills	-0.20**	-0.01	-0.02	0.17
	(0.10)	(0.12)	(0.10)	(0.13)
Mountains	-0.29**	0.19	-0.09	0.34**
	(0.14)	(0.14)	(0.13)	(0.17)
County effect	Yes	Yes	Yes	Yes

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	Male		Female	
Variables	Marriage (1)	Migration (2)	Marriage (3)	Migration (4)
Baseline				
≤19 years		7.64***	0.10	7.64
		(2.39)	(0.06)	(8.78)
20 years		8.32***	1.58***	8.32
		(2.38)	(0.07)	(8.78)
21 years[b]	-8.91***	8.46***	2.14***	8.32
	(0.07)	(2.39)	(0.07)	(8.78)
22 years	-7.43***	8.57***	2.51***	8.47
	(0.07)	(2.39)	(0.07)	(8.78)
23 years	-7.11***	8.45***	2.58***	8.51
	(0.08)	(2.39)	(0.09)	(8.78)
24 years	-6.82***	8.69***	2.82***	8.72
	(0.11)	(2.39)	(0.10)	(8.78)
25 years	-6.63***	8.80***	3.00***	8.56
	(0.12)	(2.38)	(0.13)	(8.78)
26 years	-5.23***	8.91***	3.03***	8.91
	(0.12)	(2.39)	(0.16)	(8.78)
27 years	-6.48***	8.89***	3.02***	8.95
	(0.14)	(2.38)	(0.20)	(8.78)
28 years	-6.49***	9.15***	3.04***	9.31
	(0.17)	(2.38)	(0.24)	(8.78)
29 years	-6.53***	9.01***	3.04***	8.66
	(0.20)	(2.38)	(0.31)	(8.78)
30 years	-6.65***	8.89***	3.07***	9.13
	(0.24)	(2.38)	(0.37)	(8.78)
≥31 years	-6.99***	9.21***	3.18***	9.22
	(0.25)	(2.39)	(0.35)	(8.78)
Heterogeneity				
v_{n2}	-1.83***		-1.55***	
	(0.29)		(0.28)	
v_{m2}		$-\infty$		$-\infty$

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Variables	Male		Female	
	Marriage (1)	Migration (2)	Marriage (3)	Migration (4)
Distribution of heterogeneity				
γ_2	-0.92***		-0.39***	
	(0.10)		(0.07)	
γ_3	-1.44***		-2.01***	
	(0.43)		(0.57)	
γ_4	-3.54***		-3.78***	
	(0.47)		(1.02)	
p_1	60%		55%	
p_2	24%		37%	
p_3	14%		7%	
p_4	2%		1%	
Log-likelihood	-15,860.73		-13,151.68	
Sample size	3,885		3,478	

Note: standard errors in parentheses; ***, **, and * denote significant at 1%,5% and 10% respectively; *a* Reference group: Post-1970; $b \leq 21$ years for male's marriage hazard.

Table A.6: The Full Results of Robustness Checks, Males 18-40 Years in Chapter 3

	(1)		(2)		(3)	
Variables	Marriage	Migration	Marriage	Migration	Marriage	Migration
Migration	0.17**		0.17**		0.18**	
	(0.08)		(0.07)		(0.07)	
Return migration	-0.08		-0.09		-0.08	
	(0.18)		(0.18)		(0.18)	
Marriage status		0.07		0.08		0.08
		(0.08)		(0.08)		(0.08)
Minority status	0.66	-1.97***	0.69	-1.99***	0.67	-1.95***
	(0.42)	(0.68)	(0.42)	(0.42)	(0.42)	(0.68)
Schooling years	-0.02*	0.06***	-0.04***	0.06***	-0.05***	0.06***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Birth order	-0.04**	0.01	-0.04**	-0.01	-0.05**	-0.01
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Enrolment	-0.94***	-0.79***	-1.25***	-1.02***	-1.24***	-1.02***
	(0.16)	(0.07)	(0.33)	(0.12)	(0.33)	(0.12)
Social networks	0.00	0.00	0.00	0.00	0.00	0.00
	(0.00)	(0.00)	(0.36)	(0.00)	(0.00)	(0.00)

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Variables	(1) Marriage	(1) Migration	(2) Marriage	(2) Migration	(3) Marriage	(3) Migration
Post-1980	-0.81***	1.55***	-0.86***	1.61***	-0.80***	1.43***
	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.08)
Sex ratio	-0.74**	-0.36	-0.38*	-0.11	-1.00***	-0.11
	(0.29)	(0.29)	(0.25)	(0.24)	(0.33)	(0.33)
Average schooling years of males	0.91**		0.85**		0.86**	
	(0.36)		(0.37)		(0.36)	
Average schooling years of individuals		-1.81***		-1.75***		-1.85***
		(0.32)		(0.32)		(0.32)
Terrain (reference group: Plains)						
Hills	-0.19**	-0.03	-0.20*	-0.02	-0.20**	-0.01
	(0.10)	(0.12)	(0.10)	(0.12)	(0.10)	(0.12)
Mountains	-0.28**	0.15	-0.29**	0.18	-0.29**	0.18
	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)
County effect	Yes	Yes	Yes	Yes	Yes	Yes
Baseline						
≤19 years		7.64***		7.64***		7.64***
		(2.39)		(2.40)		(2.37)

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	(1)		(2)		(3)	
Variables	Marriage	Migration	Marriage	Migration	Marriage	Migration
20 years		8.32***		8.32***		8.32***
		(2.38)		(2.39)		(2.39)
21 years	-8.91***	8.46***	-8.92***	8.32***	-8.92***	8.32***
	(0.07)	(2.39)	(0.07)	(2.35)	(0.07)	(2.35)
22 years	-7.42***	8.57***	-7.42***	8.47***	-7.42***	8.47***
	(0.07)	(2.39)	(0.07)	(2.38)	(0.07)	(2.37)
23 years	-7.11***	8.45***	-7.11***	8.51***	-7.11***	8.51***
	(0.08)	(2.39)	(0.08)	(2.39)	(0.08)	(2.39)
24 years	-6.82***	8.69***	-6.82***	8.69***	-6.82***	8.69***
	(0.12)	(2.39)	(0.12)	(2.39)	(0.12)	(2.39)
25 years	-6.63***	8.80***	-6.63***	8.80***	-6.63***	8.80***
	(0.12)	(2.38)	(0.12)	(2.38)	(0.12)	(2.38)
26 years	-5.23***	8.91***	-5.23***	8.91***	-5.23***	8.91***
	(0.12)	(2.39)	(0.12)	(2.39)	(0.12)	(2.39)
27 years	-6.48***	8.89***	-6.51***	8.91***	-6.51***	8.91***
	(0.14)	(2.38)	(0.14)	(2.38)	(0.14)	(2.38)
28 years	-6.49***	9.15***	-6.49***	9.15***	-6.49***	9.15***
	(0.17)	(2.38)	(0.17)	(2.38)	(0.17)	(2.38)

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Variables	(1) Marriage	(1) Migration	(2) Marriage	(2) Migration	(3) Marriage	(3) Migration
29 years	-6.53***	9.01***	-6.53***	9.01***	-6.53***	9.01***
	(0.20)	(2.38)	(0.20)	(2.38)	(0.20)	(2.38)
30 years	-6.65***	8.89***	-6.65***	8.84***	-6.65***	8.84***
	(0.24)	(2.38)	(0.24)	(2.38)	(0.24)	(2.38)
$\geq$31 years	-6.99***	9.21***	-6.99***	9.21***	-6.99***	9.21***
	(0.25)	(2.39)	(0.25)	(2.39)	(0.25)	(2.39)
Heterogeneity						
v_{n2}	-1.70***		-1.81***		-1.81***	
	(0.29)		(0.28)		(0.28)	
v_{m2}		$-\infty$		$-\infty$		$-\infty$
Distribution of heterogeneity						
γ_2	-0.91***		-0.93***		-0.93***	
	(0.09)		(0.08)		(0.08)	
γ_3	-1.39***		-1.47***		-1.52***	
	(0.45)		(0.39)		(0.39)	
γ_4	-3.41***		-3.45***		-3.52***	
	(0.51)		(0.46)		(0.46)	
p_1	59%		60%		61%	

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	(1)		(2)		(3)	
Variables	Marriage	Migration	Marriage	Migration	Marriage	Migration
p_2	24%		24%		24%	
p_3	15%		14%		13%	
p_4	2%		2%		2%	
Log-likelihood	-15,840.21		-15,868.82		-15,859.47	
Sample size	3,885		3,478		3,478	

Note: standard errors in parentheses; ***, **, and * denote significant at 1%,5% and 10% respectively.

Table A.7: The Full Results of Robustness Checks, Females 16-40 Years in Chapter 3

	(1)		(2)		(3)	
Variables	Marriage	Migration	Marriage	Migration	Marriage	Migration
Migration	-0.29**		-0.28***		-0.26**	
	(0.07)		(0.07)		(0.07)	
Return migration	0.00		0.00		0.02	
	(0.20)		(0.20)		(0.20)	
Marriage status		-0.03		-0.03		-0.02
		(0.09)		(0.09)		(0.09)

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	(1)		(2)		(3)	
Variables	Marriage	Migration	Marriage	Migration	Marriage	Migration
Minority status	-0.13	-0.63	-0.15	-0.63	-0.14	-0.56
	(0.31)	(0.61)	(0.33)	(0.61)	(0.32)	(0.61)
Schooling years	-0.06***	0.07***	-0.09***	0.09***	-0.09***	0.09***
	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)	(0.01)
Birth order	-0.04**	0.01	-0.05**	-0.01	-0.05**	-0.01
	(0.02)	(0.03)	(0.02)	(0.02)	(0.02)	(0.03)
Enrolment	-1.16***	-0.58***	-1.27***	-1.17***	-1.27***	-1.15***
	(0.13)	(0.09)	(0.30)	(0.16)	(0.30)	(0.16)
Social networks	0.00	0.00	0.00	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Post-1980	-0.41***	1.98***	-0.44***	2.03***	-0.38***	1.77***
	(0.06)	(0.10)	(0.06)	(0.10)	(0.06)	(0.10)
Sex ratio	-0.49**	-0.05	-0.23	-0.44	-0.83***	-0.11
	(0.27)	(0.38)	(0.24)	(0.32)	(0.31)	(0.43)
Average schooling	0.22		-0.25		-0.21**	
years of females	(0.25)		(0.25)		(0.25)	
Average schooling		-1.80***		-1.78***		-1.96***
years of individuals		(0.48)		(0.48)		(0.48)

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	(1)		(2)		(3)	
Variables	Marriage	Migration	Marriage	Migration	Marriage	Migration
Terrain (reference group: Plains)						
Hills	-0.02	0.18	-0.02	0.15	-0.02	0.18
	(0.09)	(0.14)	(0.10)	(0.14)	(0.10)	(0.14)
Mountains	-0.10	0.43**	-0.10	0.40**	-0.10	0.41**
	(0.13)	(0.17)	(0.13)	(0.14)	(0.13)	(0.17)
County effect	Yes	Yes	Yes	Yes	Yes	Yes
Baseline						
≤19 years	0.08	7.45	0.08	7.45	0.08	7.45
	(0.07)	(5.69)	(0.07)	(5.69)	(0.07)	(5.69)
20 years	1.56***	8.05	1.56***	8.05	1.56***	8.05
	(0.07)	(5.67)	(0.07)	(5.67)	(0.06)	(5.67)
21 years	2.12***	8.06	2.12***	8.05	2.12***	8.05
	(0.07)	(5.67)	(0.07)	(5.67)	(0.07)	(5.67)
22 years	2.49***	8.20	2.49***	8.20	2.49***	8.19
	(0.08)	(5.69)	(0.08)	(5.69)	(0.09)	(5.69)
23 years	2.57***	8.22	2.57***	8.23	2.57***	8.23
	(0.09)	(5.65)	(0.09)	(5.68)	(0.09)	(5.68)

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	(1)		(2)		(3)	
Variables	Marriage	Migration	Marriage	Migration	Marriage	Migration
24 years	2.81***	8.45	2.81***	8.45	2.81***	8.45
	(0.11)	(5.67)	(0.11)	(5.67)	(0.12)	(5.66)
25 years	3.00***	8.3	3.00***	8.3	3.00***	8.3
	(0.14)	(5.68)	(0.14)	(5.68)	(0.14)	(5.68)
26 years	3.04***	8.67	3.04***	8.65	3.04***	8.65
	(0.17)	(5.69)	(0.17)	(5.69)	(0.17)	(5.69)
27 years	3.03***	8.69	3.03***	8.69	3.03***	8.69
	(0.21)	(5.67)	(0.21)	(5.68)	(0.21)	(5.68)
28 years	3.05***	9.05	3.05***	9.05	3.05***	9.05
	(0.25)	(5.69)	(0.25)	(5.69)	(0.25)	(5.69)
29 years	3.05***	8.40	3.05***	8.40	3.05***	8.40
	(0.32)	(5.68)	(0.32)	(5.68)	(0.32)	(5.68)
30 years	3.04***	8.86	3.04***	8.86	3.04***	8.86
	(0.37)	(5.68)	(0.37)	(5.68)	(0.37)	(5.68)
≥31 years	3.13***	8.93	3.13***	8.93	3.13***	8.93
	(0.34)	(5.69)	(0.34)	(5.69)	(0.34)	(5.69)

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	(1)		(2)		(3)	
Variables	Marriage	Migration	Marriage	Migration	Marriage	Migration
Heterogeneity						
v_{n2}	-1.29***		-1.47***		-1.45***	
	(0.29)		(0.28)		(0.27)	
v_{m2}		$-\infty$		$-\infty$		$-\infty$
Distribution of heterogeneity						
γ_2	-0.37***		-0.44***		-0.41***	
	(0.10)		(0.08)		(0.08)	
γ_3	-1.67***		-1.83***		-1.80***	
	(0.60)		(0.55)		(0.54)	
γ_4	-3.82***		-3.69***		-3.73***	
	(1.25)		(1.00)		(1.05)	
p_1	53%		55%		54%	
p_2	36%		35%		36%	
p_3	10%		9%		9%	
p_4	1%		1%		1%	
Log-likelihood	-13,110.52		-13,119.70		-13,131.27	
Sample size	3,478		3,478		3,478	

Note: standard errors in parentheses; ***, **, and * denote significant at 1%,5% and 10% respectively.

Table A.8: The Full Results of the Heterogeneous Effect of Rural-Urban Migration in China, Males 18-40 Years in Chapter 3

	(1)		(2)		(3)	
Variables	Marriage	Migration	Marriage	Migration	Marriage	Migration
The heterogeneity in the migration effect						
Time since migration						
the 1st year	0.22**		0.22*		0.05	
	(0.11)		(0.12)		(0.20)	
the 2nd year	0.15		0.16		-0.02	
	(0.11)		(0.12)		(0.20)	
the 3rd year	0.17		0.17		-0.01	
	(0.11)		(0.12)		(0.20)	
the 4th and 5th years	0.10		0.10		-0.08	
	(0.10)		(0.11)		(0.20)	
later than the 5th year	0.34***		0.34***		0.16	
	(0.11)		(0.13)		(0.21)	

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	(1)		(2)		(3)	
Variables	Marriage	Migration	Marriage	Migration	Marriage	Migration
Individual characteristics						
Post-1980			0.00		0.00	
			(0.11)		(0.11)	
Education level						
Middle schools					0.21	
					(0.17)	
High schools					0.12	
					(0.19)	
Return migration	-0.05		-0.05		-0.08	
	(0.18)		(0.19)		(0.18)	
Marriage status		0.09		0.09		0.03
		(0.08)		(0.08)		(0.01)
Minority status	0.69	-1.98***	0.69	-1.98***	0.67	-1.95***
	(0.42)	(0.69)	(0.42)	(0.69)	(0.42)	(0.68)
Schooling years	-0.04***	0.06***	-0.04***	0.06***	-0.04***	0.11***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)

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	(1)		(2)		(3)	
Variables	Marriage	Migration	Marriage	Migration	Marriage	Migration
Birth order	-0.04**	0.01	-0.04**	-0.01	-0.05**	0.03
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Enrolment	-1.25***	-1.02***	-1.25***	-1.02***	-1.25***	-2.87***
	(0.33)	(0.12)	(0.33)	(0.12)	(0.33)	(0.12)
Social networks	0.00	0.00	0.00	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Post-1980	-0.83***	1.54***	-0.83***	1.54***	-0.83***	1.81***
	(0.07)	(0.07)	(0.08)	(0.07)	(0.08)	(0.08)
Sex ratio	-0.76**	-0.33	-0.76**	-0.33	-0.76***	-0.05
	(0.29)	(0.29)	(0.30)	(0.29)	(0.29)	(0.45)
Average schooling years of males	0.85**		0.85**		0.85**	
	(0.36)		(0.36)		(0.36)	
Average schooling years of individuals		-1.79***		-1.79***		-1.84***
		(0.32)		(0.32)		(0.32)
Terrain (reference group: Plains)						
Hills	-0.19*	-0.01	-0.19*	-0.01	-0.19**	-0.07
	(0.10)	(0.12)	(0.10)	(0.12)	(0.10)	(0.09)

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Variables	(1) Marriage	(1) Migration	(2) Marriage	(2) Migration	(3) Marriage	(3) Migration
Mountains	-0.29**	0.18	-0.29**	0.18	-0.29**	0.21
	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)	(0.08)
County effect	Yes	Yes	Yes	Yes	Yes	Yes
Baseline						
≤19 years		7.64***		7.64***		7.64***
		(2.39)		(2.40)		(2.37)
20 years		8.32***		8.32***		8.32***
		(2.38)		(2.39)		(2.39)
21 years	-8.91***	8.46***	-8.92***	8.32***	-8.92***	8.32***
	(0.07)	(2.39)	(0.07)	(2.35)	(0.07)	(2.35)
22 years	-7.41***	8.57***	-7.42***	8.47***	-7.42***	8.47***
	(0.07)	(2.39)	(0.07)	(2.38)	(0.07)	(2.37)
23 years	-7.11***	8.43***	-7.10***	8.51***	-7.14***	8.51***
	(0.08)	(2.39)	(0.08)	(2.39)	(0.08)	(2.39)
24 years	-6.82***	8.69***	-6.82***	8.69***	-6.82***	8.71***
	(0.12)	(2.39)	(0.12)	(2.39)	(0.12)	(2.39)
25 years	-6.63***	8.79***	-6.63***	8.80***	-6.63***	8.80***
	(0.12)	(2.38)	(0.12)	(2.38)	(0.12)	(2.38)

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	(1)		(2)		(3)	
Variables	Marriage	Migration	Marriage	Migration	Marriage	Migration
26 years	-5.23***	8.91***	-5.23***	8.90***	-5.23***	8.89***
	(0.12)	(2.39)	(0.12)	(2.39)	(0.12)	(2.39)
27 years	-6.48***	8.89***	-6.51***	8.91***	-6.51***	8.91***
	(0.14)	(2.38)	(0.14)	(2.38)	(0.14)	(2.38)
28 years	-6.50***	9.16***	-6.49***	9.14***	-6.49***	9.14***
	(0.17)	(2.38)	(0.17)	(2.38)	(0.17)	(2.38)
29 years	-6.53***	9.01***	-6.53***	9.01***	-6.55***	9.01***
	(0.20)	(2.38)	(0.20)	(2.38)	(0.20)	(2.38)
30 years	-6.67***	8.89***	-6.65***	8.84***	-6.65***	8.84***
	(0.24)	(2.38)	(0.24)	(2.38)	(0.24)	(2.38)
$\geq$31 years	-6.99***	9.21***	-6.99***	9.21***	-6.99***	9.21***
	(0.25)	(2.39)	(0.25)	(2.39)	(0.25)	(2.39)
Heterogeneity						
v_{n2}	-1.82***		-1.82***		-1.80***	
	(0.26)		(0.26)		(0.27)	
v_{m2}		$-\infty$		$-\infty$		$-\infty$
Distribution of heterogeneity						
γ_2	-0.91***		-0.91***		-0.91***	

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	(1)	(2)	(3)
Variables	Marriage Migration	Marriage Migration	Marriage Migration
	(0.09)	(0.09)	(0.09)
γ_3	-1.37***	-1.37***	-1.38***
	(0.36)	(0.36)	(0.38)
γ_4	-3.48***	-3.48***	-3.48***
	(0.51)	(0.46)	(0.47)
p_1	59%	59%	59%
p_2	24%	24%	24%
p_3	15%	15%	15%
p_4	2%	2%	2%
Log-likelihood	15863.38	-15,863.88	-15862.30
Sample size	3,885	3,885	3,885

Note: standard errors in parentheses; ***, **, and * denote significant at 1%,5% and 10% respectively.

Table A.9: The Full Results of the Heterogeneous Effect of Rural-Urban Migration in China, Females 16-40 Years in Chapter 3

	(1)		(2)		(3)	
Variables	Marriage	Migration	Marriage	Migration	Marriage	Migration
The heterogeneity in the migration effect						
Time since migration						
the 1st year	0.02		0.26*		0.18	
	(0.13)		(0.15)		(0.19)	
the 2nd year	-0.11		0.15		0.07	
	(0.12)		(0.15)		(0.19)	
the 3rd year	-0.38***		-0.11		-0.19	
	(0.13)		(0.16)		(0.20)	
the 4th and 5th years	-0.48***		-0.20		-0.29	
	(0.11)		(0.14)		(0.19)	
later than the 5th year	-0.41***		-0.13		-0.24	
	(0.13)		(0.16)		(0.20)	

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	(1)		(2)		(3)	
Variables	Marriage	Migration	Marriage	Migration	Marriage	Migration
Individual characteristics						
Post-1980			-0.38***		-0.37***	
			(0.11)		(0.13)	
Education level						
Middle schools					0.15	
					(0.15)	
High schools					-0.16	
					(0.20)	
Return migration	-0.01		-0.04		-0.05	
	(0.14)		(0.18)		(0.20)	
Marriage status		-0.03		-0.03		-0.03
		(0.09)		(0.09)		(0.09)
Minority status	-0.14	-0.61	-0.13	-0.61	-0.11	-0.61
	(0.33)	(0.61)	(0.33)	(0.61)	(0.35)	(0.60)
Schooling years	-0.10***	0.09***	-0.10***	0.09***	-0.10***	0.09***
	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)	(0.02)
Birth order	-0.05**	-0.01	-0.05**	-0.01	-0.05**	-0.01
	(0.02)	(0.03)	(0.02)	(0.03)	(0.02)	(0.03)

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	(1)		(2)		(3)	
Variables	Marriage	Migration	Marriage	Migration	Marriage	Migration
Enrolment	-1.25***	-1.16***	-1.26***	-1.16***	-1.26***	-1.16***
	(0.30)	(0.16)	(0.30)	(0.16)	(0.30)	(0.16)
Social networks	0.00	0.00	0.00	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Post-1980	-0.41***	1.95***	-0.36***	1.95***	-0.37***	1.95***
	(0.07)	(0.10)	(0.07)	(0.10)	(0.07)	(0.10)
Sex ratio	-0.46	0.01	-0.38	-0.01	-0.37	-0.05
	(0.28)	(0.38)	(0.28)	(0.38)	(0.29)	(0.38)
Average schooling	-0.22		-0.23		-0.22	
years of females	(0.25)		(0.25)		(0.25)	
Average schooling		-1.83***		-1.83***		-1.84***
years of individuals		(0.48)		(0.48)		(0.47)
Terrain (reference group: Plains)						
Hills	-0.02	0.16	-0.03	0.16	-0.02	0.17
	(0.10)	(0.14)	(0.10)	(0.14)	(0.10)	(0.14)
Mountains	-0.09	0.41**	-0.09	0.41**	-0.08	0.41**
	(0.13)	(0.17)	(0.13)	(0.17)	(0.13)	(0.17)
County effect	Yes	Yes	Yes	Yes	Yes	Yes

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	(1)		(2)		(3)	
Variables	Marriage	Migration	Marriage	Migration	Marriage	Migration
Baseline						
≤19 years	0.08	7.45	0.08	7.45	0.08	7.45
	(0.07)	(5.69)	(0.07)	(5.69)	(0.07)	(5.69)
20 years	1.56***	8.05	1.56***	8.05	1.56***	8.05
	(0.07)	(5.67)	(0.07)	(5.67)	(0.06)	(5.67)
21 years	2.12***	8.06	2.12***	8.05	2.12***	8.05
	(0.07)	(5.67)	(0.07)	(5.67)	(0.07)	(5.67)
22 years	2.49***	8.20	2.49***	8.20	2.49***	8.19
	(0.08)	(5.69)	(0.08)	(5.69)	(0.09)	(5.69)
23 years	2.57***	8.22	2.57***	8.23	2.57***	8.23
	(0.09)	(5.65)	(0.09)	(5.68)	(0.09)	(5.68)
24 years	2.81***	8.45	2.81***	8.45	2.81***	8.45
	(0.11)	(5.67)	(0.11)	(5.67)	(0.12)	(5.66)
25 years	3.00***	8.3	3.00***	8.3	3.00***	8.3
	(0.14)	(5.68)	(0.14)	(5.68)	(0.14)	(5.68)
26 years	3.04***	8.67	3.04***	8.65	3.04***	8.65
	(0.17)	(5.69)	(0.17)	(5.69)	(0.17)	(5.69)

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	(1)		(2)		(3)	
Variables	Marriage	Migration	Marriage	Migration	Marriage	Migration
27 years	3.03***	8.69	3.03***	8.69	3.03***	8.69
	(0.21)	(5.67)	(0.21)	(5.68)	(0.21)	(5.68)
28 years	3.05***	9.05	3.05***	9.05	3.05***	9.05
	(0.25)	(5.69)	(0.25)	(5.69)	(0.25)	(5.69)
29 years	3.05***	8.40	3.05***	8.40	3.05***	8.40
	(0.32)	(5.68)	(0.32)	(5.68)	(0.32)	(5.68)
30 years	3.04***	8.86	3.04***	8.86	3.04***	8.86
	(0.37)	(5.68)	(0.37)	(5.68)	(0.37)	(5.68)
$\geq$31 years	3.13***	8.93	3.13***	8.93	3.13***	8.93
	(0.34)	(5.69)	(0.34)	(5.69)	(0.34)	(5.69)
Heterogeneity						
v_{n2}	-1.46***		-1.53***		-1.53***	
	(0.24)		(0.25)		(0.23)	
v_{m2}		$-\infty$		$-\infty$		$-\infty$
Distribution of heterogeneity						
γ_2	-0.45***		-0.45***		-0.50***	
	(0.08)		(0.07)		(0.08)	

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Variables	(1) Marriage	(1) Migration	(2) Marriage	(2) Migration	(3) Marriage	(3) Migration
γ_3	-1.66***		-1.79***		-1.61***	
	(0.54)		(0.47)		(0.41)	
γ_4	-3.16***		-3.39***		-3.19***	
	(0.98)		(0.90)		(0.72)	
p_1	53%		54%		54%	
p_2	34%		35%		33%	
p_3	10%		9%		11%	
p_4	2%		2%		2%	
Log-likelihood	-13,111.99		-13107.94		-13072.70	
Sample size	3,478		3,478		3,478	

Note: standard errors in parentheses; ***, **, and * denote significant at 1%,5% and 10% respectively.

Table A.10: The Full Results of The Effect of Migration in China on Current Smoking Status by Birth Cohorts, in Chapter 4

Birth cohort	18-40			18-30			18-25		
Models	OLS	IV	FE	OLS	IV	FE	OLS	IV	FE
Whether migrated	-0.00	0.39***	0.04***	0.03**	0.41**	0.05***	0.05***	0.21	0.04**
	(0.01)	(0.15)	(0.01)	(0.02)	(0.20)	(0.01)	(0.02)	(0.24)	(0.02)
Age	0.01	-0.02	0.13***	0.05	-0.02	0.07	0.39***	0.34***	0.28***
	(0.01)	(0.01)	(0.02)	(0.04)	(0.05)	(0.05)	(0.11)	(0.11)	(0.11)
$Age^2/1000$	0.08	0.65**	-1.05***	-0.84	0.67	0.28	-8.82***	-7.69***	-4.90*
	(0.18)	(0.28)	(0.36)	(0.75)	(1.00)	(1.03)	(2.65)	(2.70)	(2.51)
Schooling years	-0.02***	-0.02***		-0.02***	-0.02***		-0.02***	-0.01***	
	(0.00)	(0.00)		(0.00)	(0.00)		(0.00)	(0.01)	
Whether married	0.06***	0.09***	-0.03	0.07***	0.08***	-0.03	0.07**	0.07**	-0.03
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)	(0.03)
Minority status	-0.10	0.12		-0.32***	0.07		-0.20**	0.18	
	(0.29)	(0.09)		(0.08)	(0.14)		(0.09)	(0.17)	
Household income per capita (10^3 Yuan)	0.00	0.01**	0.00	0.00	0.00	-0.00	0.00	0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

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Birth cohort	18-40			18-30			18-25		
Models	OLS	IV	FE	OLS	IV	FE	OLS	IV	FE
Social networks	0.00	-0.00	0.00	0.00	-0.00	0.00	-0.00	-0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Constant	0.08	0.34*	-2.39***	-0.37	0.38	-1.56***	-3.93***	-3.41***	-3.61***
	(0.16)	(0.18)	(0.30)	(0.41)	(0.54)	(0.59)	(1.19)	(1.20)	(1.13)
County effects	Yes	No	No	Yes	No	No	Yes	No	No
Province effects	No	Yes	No	No	Yes	No	No	Yes	No
Adjusted R^2	0.14		0.06	0.12		0.07	0.13		0.07
Wald F-statistic for weak instrument		81.14			31.79			17.81	
Observations	9,196	9,196	9,196	5,108	5,108	5,108	2,852	2,852	2,852
Number of males	4,930	4,930	4,930	2,786	2,786	2,786	1,621	1,621	1,621

Note: standard errors in parentheses; ***, **, and * denote significant at 1%,5% and 10% respectively.

Table A.11: The First Stage Results of IV Models in Chapter 4

Birth cohort	18-50 Full sample	18-40	18-30	18-25
Expenditure on Supporting	-5.75***	-7.26***	-6.28***	-6.48***
Agriculture Production	(0.73)	(1.02)	(1.39)	(1.87)
Age	0.00	0.07***	0.15***	0.00
	(0.00)	(0.01)	(0.04)	(0.13)
$Age^2/1000$	-0.28***	-1.41***	-3.17***	0.61
	(0.06)	(0.18)	(0.78)	(2.97)
Schooling years	0.00	0.00	-0.00	-0.01**
	(0.00)	(0.00)	(0.00)	(0.00)
Whether married	-0.03*	-0.05***	-0.04**	-0.04
	(0.02)	(0.02)	(0.02)	(0.03)
Minority status	0.24***	0.34***	0.52***	0.44***
	(0.04)	(0.06)	(0.08)	(0.13)
Household income	-0.01***	-0.01***	-0.01***	-0.01***
per capita (10^3 Yuan)	(0.00)	(0.00)	(0.00)	(0.00)
Social networks	0.001*	0.001**	0.001***	0.002***
	(0.0002)	(0.0003)	(0.0004)	(0.0005)
Constant	0.48***	-0.53***	-1.61***	0.00
	(0.08)	(0.15)	(0.44)	(1.33)
Province effects	Yes	Yes	Yes	Yes
Wald F-statistic for weak instrument	100.50	81.14	31.79	17.81
Observations	14,417	9,196	5,108	2,852
Number of males	7,601	4,930	2,786	1,621

Note: standard errors in parentheses; ***, **, and * denote significant at 1%, 5%, and 10% respectively.

Table A.12: The Full Results of The Effect of Migration in China on the Initiation of Smoking by Birth Cohorts in Chapter 4

Birth cohort	18-40		18-30		18-25	
Enrolment age	Age 6	Age 8	Age 6	Age 8	Age 6	Age 8
Whether migrated	0.34***	0.23***	0.52***	0.38***	0.75***	0.60***
	(0.07)	(0.07)	(0.09)	(0.09)	(0.13)	(0.13)
Schooling years	-0.03**	0.016	-0.04*	0.01	-0.04	0.00
	(0.01)	(0.014)	(0.02)	(0.02)	(0.04)	(0.03)
Minority status	0.27	0.24	0.37	0.39	0.08	0.06
	(0.73)	(0.73)	(0.50)	(0.50)	(0.76)	(0.76)
Enrolment	-0.83***	-1.13***	-0.82***	-1.10***	-0.89***	-0.95***
	(0.14)	(0.09)	(0.19)	(0.12)	(0.27)	(0.17)
Social networks	0.00	0.00	0.00	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Baseline						
h_1 (10-15)	-5.40***	-5.43***	-5.61***	-5.75***	-5.46***	-5.68***
	(0.32)	(0.32)	(0.51)	(0.51)	(0.65)	(0.65)
h_2 (16-20)	-2.29***	-2.45***	-2.65***	-2.82***	-2.71***	-2.79***
	(0.27)	(0.27)	(0.45)	(0.45)	(0.59)	(0.58)

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Birth cohort	18-40		18-30		18-25	
Enrolment age	Age 6	Age 8	Age 6	Age 8	Age 6	Age 8
h_3 (21-25)	-2.59***	-2.97***	-3.13***	-3.52***	-3.41***	-3.62***
	(0.28)	(0.28)	(0.46)	(0.46)	(0.61)	(0.61)
h_4 (26-30)	-3.43***	-3.81***	-3.94***	-4.32***		
	(0.29)	(0.29)	(0.49)	(0.49)		
h_5 (31-35)	-5.36***	-5.72***				
	(0.39)	(0.39)				
h_6 (36+)	-5.06***	-5.39***				
	(0.45)	(0.45)				
County effect	Yes	Yes	Yes	Yes	Yes	Yes
Birth-year effect	Yes	Yes	Yes	Yes	Yes	Yes
Log-likelihood	-6,712.53	-6,397.74	-2,700.40	-2,668.29	-1,175.02	-1,167.00
Sample size	4,441	4,441	2,479	2,479	1,457	1,457

Note: standard errors in parentheses; ***, **, and * denote significant at 1%,5% and 10% respectively.

Table A.13: The Full Results of the Robustness Check - the Assumption of Enrolment Age in Chapter 5

	The single hazard models	The bivariate hazard model	
	Smoking	Smoking	Migration
Whether ever migrated	0.16***	0.14**	
	(0.06)	(0.06)	
Schooling years	0.02*	-0.02**	0.04***
	(0.01)	(0.01)	(0.01)
Minority status	0.80	0.91	-3.12***
	(0.81)	(0.82)	(0.61)
Social networks	0.002*	0.002*	0.001
	(0.001)	(0.001)	(0.002)
Enrolment	-1.20***	-1.21***	-1.14***
	(0.07)	(0.07)	(0.06)
Baseline			
λ_{s1} (10-15 years)	-7.09***	-5.71***	
	(2.30)	(0.72)	
λ_{s2} (16-25 years)	-4.09**	-2.71***	
	(2.30)	(0.74)	
λ_{s3} (26-35 years)	-4.93***	-3.55***	
	(2.30)	(0.73)	
λ_{s4} (36+ years)	-6.41***	-5.02***	
	(2.29)	(0.71)	
λ_{m1} (16-20 years)			-7.83***
			(2.92)
λ_{m2} (21-30 years)			-7.04
			(2.92)
λ_{m3} (31-40 years)			-6.49***
			(2.93)
λ_{m4} (41+ years)			-6.06***
			(2.93)

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	The single hazard models	The bivariate hazard model	
	Smoking	Smoking	Migration
Heterogeneity distribution			
α	-1.30***		
	(0.10)		
γ_1		-1.35***	
		(0.11)	
γ_2		-2.30***	
		(0.14)	
γ_3		-3.26***	
		(0.22))	
2^{nd} mass point			
v_{s2}	$-\infty$	$-\infty$	
v_{m2}			$-\infty$
Probability of heterogeneity			
$p = Pr(v_{s1})$	78.57%		
$p_1 = Pr(v_{s1}, v_{m1})$		71.51 %	
$p_2 = Pr(v_{s1}, v_{m2})$		7.00%	
$p_3 = Pr(v_{s2}, v_{m1})$		18.59%	
$p_4 = Pr(v_{s2}, v_{m2})$		2.75%	
County effect	Yes	Yes	Yes
Birth year effect	Yes	Yes	Yes
Log-likelihood	-12,738.38	-25,750.01	
Sample Size	6,712	6,712	

Note: standard errors in parentheses; ***, **, and * denote significant at 1%, 5% and 10% respectively.

Table A.14: The Full Results of the Single Hazard Model by Various Birth Cohorts in Chapter 5

Birth cohort	18-40	18-30	18-25
Whether ever migrated	0.39***	0.65***	0.97***
	(0.07)	(0.10)	(0.13)
Schooling years	-0.03**	-0.03	-0.02
	(0.01)	(0.03)	(0.05)
Social networks	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)
Enrolment	-0.82***	-0.81***	-0.95***
	(0.14)	(0.19)	(0.28)
Baseline			
λ_{s1} (10-15 years)	-5.20***	-5.31***	-5.54***
	(1.99)	(2.34)	(3.04)
λ_{s2} (16-25 years)	-2.00	-2.23**	-2.54**
	(1.98)	(2.35)	(3.04)
λ_{s3} (26-35 years)	-2.88*	-2.23**	
	(1.99)	(2.34)	
λ_{s4} (36+ years)	-3.84***		
	(2.02)		
Heterogeneity distribution			
α	-0.89***	-0.27	0.14
	(0.10)	(0.10)	(0.11)
2^{nd} mass point			
v_{s2}	$-\infty$	$-\infty$	$-\infty$
Probability of heterogeneity			
$p = Pr(v_{s1})$	71.01%	56.74%	46.39%
County effect	Yes	Yes	Yes
Birth year effect	Yes	Yes	Yes
Log-likelihood	-7,224.25	3,130.36	-1493.61
Sample Size	4,161	2,270	1,249

Note: standard errors in parentheses; ***, **, and * denote significant at 1%, 5% and 10% respectively.

Table A.15: The Full Results of the Single Hazard Model by Various Birth Cohorts in Chapter 5

Birth cohort	18-40		18-30		18-25	
Event	Smoking	Migration	Smoking	Migration	Smoking	Migration
Whether ever migrated	0.42***		0.65***		1.00***	
	(0.12)		(0.10)		(0.14)	
Schooling years	-0.03**	0.06***	-0.04	-0.10***	0.00	-0.11***
	(0.01)	(0.01)	(0.03)	(0.01)	(0.05)	(0.02)
Minority status	0.81	-3.64***	0.30	-1.32***	-0.10	0.69
	(0.56)	(1.03)	(0.57)	(0.41)	(0.84)	(0.53)
Social networks	0.00	0.04	0.00	0.00	0.00	0.00
	(0.00)	(0.06)	(0.00)	(0.00)	(0.00)	(0.00)
Enrolment	-0.81***	-1.01***	-0.81***	-1.67***	-0.96***	-1.75***
	(0.14)	(0.06)	(0.19)	(0.11)	(0.28)	(0.13)
Baseline						
λ_{s1} (10-15 years)	-5.21***		-5.31**		-5.69***	
	(1.37)		(3.15)		(1.48)	
λ_{s2} (16-25 years)	-1.99		-2.23		-2.65*	
	(1.36)		(2.85)		(1.51)	

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Birth cohort	18-40		18-30		18-25	
Event	Smoking	Migration	Smoking	Migration	Smoking	Migration
λ_{s3} (26+ years)	-3.73*					
	(1.36)					
λ_{m1} (16-20 years)		-6.43***		-5.23**		-3.97
		(0.91)		(2.82)		(2.56)
λ_{m2} (21-30 years)		-5.34***		-4.21*		-3.10
		(0.91)		(2.82)		(2.56)
λ_{m3} (31+ years)		-4.92***				
		(0.91)				
Heterogeneity distribution						
γ_1	-4.70***		-3.26***		6.89***	
	(1.41)		(3.15)		(0.11)	
γ_2	-0.83***		-0.27**		6.69***	
	(0.10)		(0.11)		(0.10)	
γ_3	-2.16**		-3.05**		-8.52***	
	(0.15)		(0.32)		(0.22)	
2^{nd} mass point						
v_{s2}	$-\infty$		$-\infty$		$-\infty$	

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Birth cohort	18-40		18-30		18-25	
Event	Smoking	Migration	Smoking	Migration	Smoking	Migration
v_{m2}		-3.85***		-3.36***		-0.03
		(0.59)		(0.43)		(0.08)
Probability of heterogeneity						
$p_1 = Pr(v_{s1}, v_{m1})$		63.57%		54.17%		0.06%
$p_2 = Pr(v_{s1}, v_{m2})$		7.34%		2.57%		55.05%
$p_3 = Pr(v_{s2}, v_{m1})$		27.74%		41.38%		44.89%
$p_4 = Pr(v_{s2}, v_{m2})$		1.35%		1.89%		0.00%
County effect	Yes	Yes	Yes	Yes	Yes	Yes
Birth year effect	Yes	Yes	Yes	Yes	Yes	Yes
Log-likelihood	-16,690.83		-8,271.86		-4,223.89	
Sample Size	4,161		2,270		1,249	

Note: standard errors in parentheses; ***, **, and * denote significant at 1%, 5% and 10% respectively.

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